THE ECONOMIC HISTORY OF STEELMAKING

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THE ECONOMIC HISTORY OF STEELMAKING 1867–1939

A Study in Competition

by

D. L. BURN

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CONTENTS

BOOK III

WAR AND PEACE

GRAPHS AND MAPS

PREFACE

The subtitle will help to make clear the scope and focus of this book. All the main aspects of the economic history of steelmaking are touched upon, but no attempt has been made to treat them in equal density. Nor are particular aspects invariably handled with the same fullness at all stages. Thus for instance, technology figures far more prominently in Book I than later. The reasons for such changes of emphasis are, I hope, obvious; save at one point. The developments of the late 'thirties are dealt with on a more insular canvas than those of earlier periods, not because international comparison seemed to become less significant, but because I was insufficiently in touch with the most recent developments overseas to write of them in detail. The whole of the text was in proof and revised before the outbreak of the present war; therefore whenever "the War" is referred to it means the war of 1914–18.

The history of the iron industry before the period covered here has been told so often and so admirably that I have deemed it reasonable to plunge straightway into the controversial discussions of the 'sixties and 'seventies without an introductory preamble. But for readers who may be unfamiliar with the earlier history and with the rudiments of the industry's technique a short description of the iron- and steelmaking processes as they had evolved by 1867 is given in Appendix I. Two maps are included, both drawn by Mr L. D. Lambert. The first is based upon one published by the British Iron and Steel Federation to illustrate the distribution of steelmaking in Britain in 1936. This original has been both amended and amplified; the insets are new, and a new category of symbols, showing the sites of abandoned (and in most instances dismantled) works, has been introduced, in order to illustrate the changes which have occurred in the location of steelmaking in the last fifty years. No attempt has been made to show these changes for iron-smelting, save where they were significant for steelmaking; it would have

needed a larger scale. Nor was it possible to indicate changes in the distribution of ore-mining; but the data in Appendix III go some way to make amends for this. The second map is only intended to illustrate problems which figure prominently in the text; thus, for instance, of the ore and coal deposits in the area mapped, only the minette fields, and the coal used in conjunction with them, are indicated. I publish no bibliography, but I have included in the index the names of the authors most frequently cited, with the page of their first appearance.

My thanks are due to a great number of firms in this country and on the Continent, for permission to visit their works and for guidance by conversation and correspondence; and to the officers of several of the collective organisations in the industry, in particular those of the British Iron and Steel Federation and the Iron and Steel Institute. If I leave unnamed those associated with the industry who have criticised my manuscript it is only to preserve them from the embarrassing suggestion that they may agree with me. In Cambridge the chief of several debts—and they are heavy ones—are to Dr J. H. Clapham and Mr E. A. G. Robinson. Dr E. Rosenbaum formerly of Hamburg, and now at the British Library of Political and Economic Sciences, has given me advice on some obscure corners of German history; and Professor S. R. Dennison, of Swansea, greatly lightened the labour of proof-reading. I am grateful, finally, for the helpfulness of my publishers and printers while the book was in the press.

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PRINCIPAL ABBREVIATIONS

B.I.S.F. British Iron and Steel Federation.
Econ. *The Economist.*
I.C.T.R. *The Iron and Coal Trades Review.*
I.D.A.C. The Import Duties Advisory Committee.
J.I.S.Inst. *Journal of the Iron and Steel Institute.*
Kont. V. ü. d. Kartelle. *Kontradiktorische Verhandlungen über deutsche*

N.F.I.S.M. National Federation of Iron and Steel Manufacturers.

The following references are to volumes in the *Verhandlungen und Berichte des Ausschusses zur Untersuchung der Erzeugungs- und Absatzbedingungen der deutschen Wirtschaft*:

Die deutsche Eisen- und Stahlwarenindustrie.
Die deutsche eisenerzeugende Industrie.
Die Rohstoffversorgung der deutschen eisenerzeugenden Industrie.
Die deutsche Kohlenwirtschaft.
Arbeitszeit, Arbeitslohn und Arbeitsleistung im Hochofenbetriebe.
Die Arbeitsleistung in Stahl- und Walzwerken.

BOOK I

MID-VICTORIAN ALARMS

Chapter I

CRITICS AND APOLOGISTS 1867

The Paris Exhibition of 1867 brought for the first time before "the public mind" a controversy concerning the state of the iron and steel industries. At the Exhibition the English manufacturers were completely outclassed. The French industry, allotted a much larger area, was paraded "with all that showman's art which the French ironmasters, like the shopkeepers of Paris, have in their bones". There was no serious English effort to make a representative show. Some English producers, unlike their foreign rivals, had learnt that "exhibitions don't pay"; others were discouraged by meagre space; and some irresponsibly "intruded slovenly heaps of raw material mingled with pieces of rusty iron".[1] The iron industry was not the only important English industry to be challenged at Paris, if not surpassed. So the official reporters came back to England to shock the public with the news that England's industrialists, and especially the ironmasters, were vegetating while their competitors forged ahead.[2] With surprising readiness the Paris show was accepted widely as a reflection of the state of British industry. According to the *Edinburgh Review* it was no longer a matter of conjecture that England had lost first place and was fast retrogressing. The Exhibition "afforded evidence of our decline upon the largest possible scale".[3] It was not a wholly unwelcome story to those who diagnosed a want of scientific education or a surfeit of

[1] Samson Jordan, *Revue de l'Industrie du Fer en* 1867 (which forms the main part of the *Revue de l'Exposition de* 1867, published in six parts, 1867–73), III, pp. 1, 112; Correspondence in *The Times*, May 30, 1867; I. L. Bell, Communication published in *Annual Report of British Association*, 1867 (pp. 34–42), pp. 34–6.

[2] Letter of Dr Lyon Playfair published by Lord Granville in *The Times*, May 29, 1867; *Reports on the Paris Exhibition*, *P.P.* 1867–8, XXX, pp. 699–700, 702, 725.

[3] *Edinburgh Review*, April 1868, pp. 435–7. Also *Quarterly Review*, Oct. 1867, pp. 486–7.

trade unionism. The times were propitious for the alarm. After the collapse of speculations in 1866 industrialists were struggling in shrinking and "falling" markets; the ironmasters most of all, since the speculations had been largely in railways, and railways provided two-thirds of the demand for iron. While production under these influences fell, a small growing import of rolled iron from Belgium acquired an excessive significance.[1] People learned with dismay that the English manufacturer who obtained the contract for girders for the South Kensington Museum was buying them in Belgium.[2] It could only mean either that our puddlers and rollers exacted excessive wages, or that our mills were infirm and our ironmasters "deficient in skill in the manipulation and producing of the forms and sizes of rolled iron required in the present day".[3]

Stirred by the authoritative attack on his fellows, and by its favourable reception, a Cleveland ironmaster, Isaac Lowthian Bell, addressed a lengthy apologia to the British Association; thus giving to the defence, by its location, the scientific prestige which the attack had possessed by virtue of the leadership of Dr Lyon Playfair.[4] Bell—*rara avis*—was a chemist as well as an ironmaster. The evidence of the Exhibition he swept aside as irrelevant; none of the exhibits was beyond the capacity of existing English plant.[5] On the basis of twenty-five years' experience of European plants Bell could detect no change in the relative position of England and the Continent in iron manufacture. It was absurd to assert that English ironmasters were unprogressive; the view was explained by the habitual emphasis on revolutionary innovations like those of Cort and Neilson to the neglect of continuous cumulative improvement.

[1] The value of the import from Belgium was as follows: 1866, £103,000; 1867, £135,000; 1868, £146,000; 1869, £124,000.

[2] *Select Committee on Scientific Instruction*, 1867–8, xv, Q. 907. Belgian girders were also used for St Thomas's Hospital at this time, and even in Sheffield and Glasgow; *ibid.* Q. 1008; and *Report of Royal Commission on Trades Unions*, 1867–8, xxxix, Qs. 10,698, 14,606.

[3] Quoted in *The Times*, May 17, 1867.

[4] Bell, *op. cit.*

[5] Bell allowed that the French made better use than the English of the "Universal" rolling mill; *ibid.* p. 36.

In his own district, for example, within the last few years blast furnaces had been made far more economical than those elsewhere by bold increases in height, and by the use of greatly increased temperature in the blast. Continental ironmasters were admirable imitators, and made their most recent works as good as the English works, according to the English pattern. But the only novelties which they had pioneered were concerned with fuel economy—more efficient cokemaking, the use of waste heat and waste gases from furnaces as a source of power. Their leadership was due to the poorness of their coal supply. Their methods were adopted and improved upon in England directly they were commercially desirable. "With regard to the application of science the ironmasters in other countries, as here, can only lament how little chemistry has been able to effect in the blast furnace or puddling process." There was no need, therefore, for the ironmasters to wear sackcloth and ashes. Bell had misgivings about the wage earners, the royalty owners, and the railways, who seemed to him relatively exorbitant: but, in spite of them, England's iron industry was secure, on the sound basis of mineral resources unapproached in Europe.

No doubt Bell was justified in dismissing arguments based on the Paris Exhibition. But his complacency about the ironmasters was not shared by all his contemporaries whose opinions carried weight. The most direct criticism came, not unnaturally, from the Continent. The distinguished and much-travelled French metallurgist, Professor Jordan, found Bell's estimate of the help of the scientist "not calculated to advance the reputation of English ironmasters as progressive men".[1] In France, scientific control of the blast-furnace process was carried out at the best works at more stages and more meticulously than in Great Britain, with the result that production of uniform quality pig iron of predetermined specifications was more advanced.[2]

[1] Jordan, *op. cit.* III, p. 113. This volume appeared in 1869, and deals with pig-iron manufacture outside France.

[2] *Ibid.* p. 114. Cf. I–II, p. 296: "Les ingénieurs du Creusot suivent avec un soin méticuleux toutes les circonstances dont dépend l'allure des fourneaux; variations de composition des minerais, pesage des charges, variations de la pression et de la température du vent. Un laboratoire soigneusement installé permet aux chimistes

Jordan also traced the influence of inadequate co-operation of science and industry in the state of fuel economy. He was far from agreeing that Continental fuel economies were adopted in Great Britain wherever commercially desirable. Coke production was everywhere wasteful; far too much fuel was used in the furnaces of Staffordshire and South Yorkshire: whilst the use of blast-furnace gas to heat the blast and drive the blowing engines was in its infancy in all districts save Cleveland and South Wales.[1] It was at its worst in Scotland, where all attempts had proved failures—"la routine extrême des maîtres de forge est la seule cause des échecs"—and in South Staffordshire, where "les maîtres de forge ont horreur de la théorie et des théoriciens, et rien ne vaut pour eux que le *practical man*".[2] England's commercial success in spite of wasteful methods was a measure of the strength of her raw-material resources, about which Jordan was at one with Bell.[3]

The proceedings of two contemporary official inquiries showed that Jordan's comments were substantially correct. One of them—a Select Committee on Scientific Instruction[4]—was a direct result of the Paris *débâcle*: the other—a Royal Commission "appointed to inquire into the several matters relating to Coal in the United Kingdom"[5]—reflected the influence of Jevons. Both reveal an industry with remarkable variations of efficiency, not merely between different regions but within single regions.[6] Some of the witnesses dealt largely with the important advances where the pioneers were English: in particular they emphasised the recent application of Siemens's regenerative ovens to puddling, steelmaking, and heating the blast for smelting pig iron. It is evident, however, that the Continental

de l'établissement d'analyser leurs minerais, leur fontes, leurs laitiers et même les gaz des hauts-fourneaux et des fours à coke." Cf. also pp. 323, 419. In L. Beck's *Geschichte des Eisens*, v (1900), p. 72, a comparison of English and German practice about 1870 is given similar to Jordan's comparison of English and French. Beck (who had contemporary knowledge) attributes English routine partly to a habitual use of adjacent ore and coal.

[1] Jordan, *op. cit.* III, p. 114.
[2] *Ibid.* pp. 11, 79.
[3] *Ibid.* pp. 114–15.
[4] *P.P.* 1867–8, xv.
[5] *P.P.* 1871, XVIII: referred to subsequently as *R.C. on Coal* (1871).
[6] E.g. *S.C. on Scientific Instruction*, Q. 1599.

forms of fuel economy were still novelties in most parts of England, although often commercially valuable.

The most interesting evidence of a general character bearing on this point given to the Select Committee was that of Dr Percy, Professor of Metallurgy in the School of Mines. His prejudices were insular. He thought the best of the works in Cleveland and South Wales equalled le Creusot and Westphalia in fuel economy. But to the query "I understand you to say that Englishmen on the whole are as economical in the use of fuel as foreigners", he returned the guarded reply, "When they are obliged to be so they are more so than they used to be".[1] Like other witnesses, he exhibited South Staffordshire just waking up to fuel economy; but not yet very active. "When fuel is becoming exhausted, and the iron ore too, it is very difficult to induce men to lay out money in accordance with new ideas."[2] There was some reason in this, though it could scarcely justify the adoption of modes of using gas which had already been proved inadequate elsewhere.[3] Scotland could not shelter under the excuse forthcoming for Staffordshire; but it was not discussed in these inquiries.

The Coal Commission heard evidence from Menelaus, manager of the Dowlais Works and thus a leading representative of the Welsh industry, and from Lowthian Bell himself, representing mainly the North-East Coast. According to Menelaus the greatest waste of fuel came about through the use of blast furnaces for unduly long "campaigns". "At present the good working of a furnace is to some extent an accident, but it might be much less so if more care and attention were paid to the

[1] *Ibid.* Q. 1583. Dr Percy, stressing recent English advance in fuel economy, was unfortunate enough to select as an illustration a Welsh zinc-smelting works, where the owner, Hussey Vivian—trained at Freiberg, employed both a German superintendent and a German process: Q. 1575.

[2] *Ibid.* Q. 1471.

[3] Jordan, *op. cit.* III, pp. 79–80. The early history of blast-furnace gas utilisation in South Staffordshire is traced in *Transactions of the Institute of Mechanical Engineers*, 1860, pp. 255 sqq.; 1865, pp. 235 sqq. Three attempts (there were 120 furnaces) failed in the 'fifties, but a single success (by a Welsh method) in 1860 had established the very considerable possible saving, and its importance where coal was becoming scarce was emphasised.

materials used in lining the furnace, and by steadily blowing out and re-lining as soon as a furnace through wear and tear or other causes consumes more than a standard quantity of coal." "Old-fashioned notions" kept furnaces in blast for years with a coal consumption 10 cwt. per ton of iron in excess of a reasonable standard, and producing poorer quality iron since impurities from an unnecessarily large quantity of fuel entered the pig.[1] Taking a more general view of the industry, Menelaus recognised "a wide field for economy for the production and use of steam in most ironworks". The use of blast-furnace gases was an old-established success in Wales, and Dowlais had recently started using the waste heat of puddling furnaces, which normally escaped up the chimney, for raising steam. The plan had been advocated as early as 1856 by Warrington Smyth, in view of its Continental success, in his report on the first Paris Exhibition.[2] Menelaus defended its neglect hitherto in Wales on the ground that it sometimes paid better "to employ our capital in extensions on the old plan rather than on improvements".[3] The argument is to be accepted with reserve, since Bell, ever on his guard against commercial rashness, accepted the use of such heat as a matter of course, and in accordance with the general practice of the North-East.[4] It is probable that extensions in Wales had been made usually to take advantage of high prices rather than to prepare for low prices.

Bell was in a different, far less complacent, mood as a witness before the Coal Commission than as an apologist before the British Association. He was "not prepared to say that there is as large a change as one would desire to see" from the "tendency to waste" which was a legacy of very cheap coal twenty-five years earlier.[5] In addition to giving details of the important Cleveland innovations in blast-furnace design, Bell described a slight and rather sluggish stream of experiment in the North-East with the characteristic Continental processes for coke

[1] *R.C. on Coal* (1871), p. 437.

[2] *Reports on the Paris Exhibition*, 1856, XXXVI, Pt. II, p. 46. The whole of Warrington Smyth's report (pp. 26–43) is valuable for its comparison of English and Continental methods at this early date.

[3] *R.C. on Coal* (1871), p. 438. [4] *Ibid.* p. 442. [5] *Ibid.* p. 440.

manufacture. He had himself, on the French plan, saved by-product tar and ammonia, and found that it did not pay.[1] With a few other makers he was using modified beehive coke ovens, which had flues under the floor in which the "waste" gases were burned to provide heat, and he considered the result was satisfactory inasmuch as he obtained a yield of coke far nearer the potential yield of the coal used, in a shorter time, and suitable for the blast furnace. But he had not been able to persuade the market that the coke differed from ordinary beehive in appearance only.[2] Apparently no one experimented at this time with the Belgian narrow retort ovens, heated through side walls. Bell found the use of the waste gases of the coke ovens to raise steam a failure commercially, since the loss of heat in taking steam some distance to the engines was excessive; this was clearly a fault or misfortune in plant disposition, though Bell did not make the obvious comment.[3] His evidence disposed, by implication, of a favoured argument that to use waste gases spoiled the coke. Menelaus in 1869 was contemplating the use of the waste gases in Wales, and Bell was prepared to believe it might pay.[4] Up to 1869, according to Bell, the production of coke from small coal, after washing, had proved unsuccessful commercially in the North-East—partly because the coke was less hard, partly because the margin of price between small and large coal was too slight; it succeeded in South Wales, where the margin was larger.[5]

In its discussions the Coal Commission considered the problem of fuel economy in steam-engine and boiler design, a subject important for the iron industry, though considered without specific reference to it. New types of engines—compound engines, or engines with improved valves—were strongly advocated, as effecting a saving of from 50 to 65 per cent of fuel; and plain cylindrical boilers, externally fired (known colloquially as "egg-ended" boilers), were condemned as both wasteful and

[1] *Ibid.* p. 441. [2] *Ibid.* p. 442. [3] *Ibid.* p. 441.

[4] *Ibid.* pp. 439, 441. Bell's optimism was partly grounded on a rise in coal prices.

[5] *Ibid.* p. 444.

dangerous.[1] For the use of inefficient boilers the coal industry was assailed:[2] and the iron industry was indirectly implicated. The material gives no basis for an international comparison.[3] In England two factors disposed manufacturers against the new types of plant: greater initial outlay, and the need of greater care and more repairs—though it was maintained, not merely by the makers of engines, that these extra costs were more than balanced by a reduction in fuel costs.[4] The new fashions were spreading mainly in the Lancashire area, not in the iron and steel districts.[5]

The Coal Commission evidence showed both the scope for fuel economy and a growing awareness of its importance on the part of more progressive ironmasters, particularly in Cleveland and South Wales. They had been stimulated partly by Jevons's startling book on the prospects of coal exhaustion, which made fuel economy a fashion, and partly by the complex impact of foreign advance, which was at once suggestive, threatening, and a blow to pride. Their new alertness received formal expression in the founding of the Iron and Steel Institute in 1869 to facilitate joint discussion of technical (but not economic) problems; a first significant national recognition in the industry of the waste of unlimited individualism. As Jordan had pointed out, however, the members of the industry were not well qualified to adopt or adapt new ideas quickly; and this handicap was made apparent by several witnesses before the Select Committee on Scientific Instruction.

These witnesses, who did not necessarily represent the general opinion of ironmasters, were impressed by the value of the technical training available widely on the Continent for the

[1] *R.C. on Coal* (1871), evidence of Sir W. Armstrong, pp. 452–3; C. W. Siemens, p. 434; John Hick (of Hargreaves and Co.), pp. 473–8; L. E. Fletcher, pp. 510–13.

[2] *Ibid.* p. 512.

[3] But John Anderson, an English juror at Paris, notes that "he was very much struck with the points of economy in many of the foreign engines, and so were all the jurors". The French and Germans were working on a theoretic basis—more so apparently than in England: *ibid.* p. 505.

[4] *Ibid.* pp. 452, 477–8, 512.

[5] *Ibid. loc. cit.* Also *Journal of the Iron and Steel Institute*, 1871, I, p. 56.

various grades of an ironworks' staff.[1] They were agreed that at least the imitative aspect of the rapid Continental industrial advance owed much to this training; and the unevenness of British development, the existence of varieties of process in single districts not justified by any local circumstance, was held by Percy and others to reflect inadequate education.[2] In one direction the trained scientist had been making some recent headway in the industry; for it was becoming more customary for important ironworks to employ a chemist—"a well-instructed man, capable of making assays, and so forth".[3] But the position, as indicated by Robert Hunt, the keeper of Mining Records, was very humble; the chemist was employed at a low salary for the analysis of ores; and "this seems to be the only scientific department".[4] Other members of an ironworks' staff normally had no specific technical training.

The only strictly metallurgical education given in England was given at the School of Mines in London. It could not have been more inconveniently situated for the iron industry. Percy, who presided there, allowed that many managers and foremen could not afford to have a London training; though he also stated that many owners sent up managers and foremen for a few months' training.[5] He was speaking with all metallurgical industries in mind, and not merely the iron industry; and it was undoubtedly not common in England to meet with men who had the scientific qualifications appropriate in an ironworks. James Kitson, a prominent West Riding ironmaker, did not know of a single West Riding ironworks' manager who had had a Jermyn Street training, nor one "who understands the simple elements of chemistry". This was in the district that produced the best-quality English puddled iron, and was afraid of departing from routine for fear of lowering the quality. Kitson found that managers in France "were invariably men of better education and of a superior stamp altogether to the men we have here"; and he attributed to this the rapid strides made by

[1] *S.C. on Scientific Instruction*, p. vii.
[2] *Ibid.* Q. 1599.
[3] *Ibid.* Q. 1461.
[4] *Ibid.* Q. 1822.
[5] *Ibid.* Qs. 1469, 1472, 1521.

French industry of late. On a recent occasion when he decided to take up the manufacture of steel locomotive tyres after the manner of Krupp, he had given practical proof of his conviction, for he "had found it necessary to go to France" for a manager. The operation was new to the Frenchman, but his scientific education "avoided much experimenting and groping necessary with an English manager".[1] At times managers were astonishingly uneducated. Mr Bagnall, a Yorkshire M.P., stated that he had been obliged in 1858 to appoint as manager of a large ironworks a man who could neither read nor write; "the difficulty in procuring educated workmen had scarcely lessened up to the present day".[2] Even in the 'eighties at least one of the leading South Staffordshire blast-furnace plants was managed by a person who had not been instructed in "the three 'R's".[3] Among lower grades in the industry the deficiencies of training were naturally more widespread than among the managers. Cochrane, a progressive Middlesbrough ironmaster (who also owned a works in Staffordshire), emphasised the difficulty in the North-East Coast area of discovering foremen with "the requisite amount of scientific knowledge". It was not difficult to get "good foremen", but "what are called good foremen are capable of such gross mistakes, from their ignorance of primary education, (that) it is pitiable to see a man in the position and yet capable of such mistakes".[4] Cochrane implied that this was a handicap, and the view was shared largely by Cleveland ironmasters.[5] The industrialists of the Midlands (and some in all probability elsewhere), who had generally had no technical training themselves, did not appreciate the handicap, and they were not for the most part giving their sons either a long or a scientific education; some were prepared to believe that such an education given to a workman would vitiate his chance of

[1] *S.C. on Scientific Instruction*, Qs. 4906–30, 4997. Kitson was a locomotive maker as well as an ironmaker: he thought that, in ironworks, French and Belgian workmen equalled the British in dexterity, but that the English were ahead in mechanical operations: Q. 4942.

[2] *Hansard*, 3rd series, CXCI, p. 168.

[3] Private information.

[4] *S.C. on Scientific Instruction*, Qs. 7210–22.

[5] E.g. by Sir Bernhard Samuelson, who became a prominent advocate of technical education.

becoming manually accomplished and adroit enough to hold a foreman's post; while those who feared their workmen coming in kid gloves were legion.[1]

Contemporary with the inquiries into the technical aspect of the iron industry's problems, there was a discussion of foreign competition from a very different angle in the untechnical atmosphere of the Royal Commission on Trade Unions. Scarcely a criticism of the ironmasters' competence was allowed to ruffle these proceedings. A succession of employers testified that competition was becoming more difficult mainly through the height of English wages, and that wages were high largely on account of trade unions.

Relatively stable trade unions were a new experience for the ironmasters of any district within the last five years.[2] Since 1848 there had been a traditional sliding scale of wages in the Staffordshire industry. In 1863, at a time of improving business, when orders rapidly increased though prices remained stationary, a new local union had succeeded in raising the basic wage on which the sliding scale rested. In the following two years masters advanced prices to a very high level and wages followed. A similar situation occurred in the North-East, where unionism quickly obtained a firm hold. There was one witness before the Commission who attributed the extremely high prices to high wages, and these to unions: but the sequence of events was against him. Prices rose even where unions did not exist: in Wales, for instance, and Scotland. The final rise of price, according to the same witness (manager of the Earl of Dudley's Round Oak Works), "diverted trade out of its proper channels".[3] In the words of another maker, "an injudicious price... allowed Belgium into the ground, and it could not be beaten back again".[4] English prices were quickly adjusted, but makers met with opposition to wage reductions on the part of the unions, and some long, unsuccessful, but nevertheless injurious,

[1] See evidence of J. Chance, *S.C. on Scientific Instruction*, Qs. 6645–75, and of R. Hunt, Q. 1818.

[2] *R.C. on Trade Unions, P.P.* 1867–8, xxxix. E.g. evidence of John Kane, Qs. 8205 sqq.; and paper by John Jones, in *Fifth Report*, pp. 53–60.

[3] *Ibid.* Q. 10,928. [4] *Ibid.* Q. 10,939. The witness was Robert Heath.

strikes occurred. It is interesting that on this occasion the ironmasters agreed that Belgian iron was as good as English iron for similar purposes. Nor did they advance the view which in other circumstances was popular and was perhaps partly true that Belgian success lay mainly in the production of girders,[1] to which the Belgian home market had given a more favourable reception than the English, and for which it had been worth while developing special plant.

Despite the serious importance attached to comparative wage costs, the discussions were amazingly insubstantial. Details of costs were kept in an individualist privacy. A great deal of time was taken up in an endeavour to prove by repeated assertion that 90 per cent of the selling price of iron was accounted for by labour cost. From which it must follow that when prices fall 10 per cent wages must respond; otherwise profits would disappear. "A man may live upon less, but a master cannot live upon nothing." To which Kane, the Ironworkers' Secretary, gave the retort that you see more paupers made of men than bankrupts made of employers.[2] In an industry like the iron industry, where capital costs were high, the percentage argument advanced was valueless.[3] There was, indeed, evidence before the Commission both from South Wales and the North-East Coast of masters who were living on less than nothing rather than close their works, relying on the restoration of their fortunes when trade revived.[4] The Dowlais witness who was selling at a loss, "drawing on capital" to pay wages, was not alarmed—he would recoup on high-price orders; nor was he alarmed at the Belgian competition which occasionally "checked" his prices.[5]

[1] See e.g. Percy's evidence in *S.C. on Scientific Instruction*, Q. 1511.

[2] *R.C. on Trade Unions*, 1867–8, xxxix, Q. 8358.

[3] *Ibid.* Q. 8505. Frederick Harrison recognised the validity of this fact as an attack on the ironmasters' argument and on the sliding scale proposals. He could not persuade Kane, the workers' representative. Cf. also evidence of W. Williams on the "ruinous effect" on overhead costs of producing small quantities: *ibid.* Q. 9986.

[4] *Ibid.* Qs. 9537, 10,192. It was said that a North-East Coast firm which was losing 5*s.* per ton on rails would lose 10*s.* against every 5*s.* if it were inactive, on account of standing charges, rates, taxes and depreciation.

[5] *Ibid.* Qs. 10,086, 10,157, 10,192.

None of the witnesses from the iron industry who came before the Commission doubted that the British ironworkers' wages were higher than those of the Continental worker. What the precise difference was it is impossible to judge. Walter Williams, a Staffordshire ironmaster who was part-author of a well-known contemporary tract on German and Belgian competition, gave evidence that Belgian wages were 20 or 30 per cent lower than those in England.[1] Alone of the English ironmasters Williams had collected some figures on the spot; and most of the other witnesses were merely echoing his words. Trade-union witnesses, excusably, had no information for international comparisons. Williams's generalisation may not have been wholly misleading—though a just estimate was exceptionally difficult to make. There was, in the first place, no uniform rate of wages in England; Welsh wages were notoriously much lower than those of Staffordshire and the North-East.[2] There were a great number of types of work involved, and piece rates for specific occupations, e.g. puddling or rolling, varied to a surprising extent according to the quality of the raw material used or the final product, and according to the plant. "There are scarcely two mills in the country...where the prices are exactly the same for mill work", said one trade-union witness.[3] A final difficulty in making the sort of international comparison which Williams aimed at appears when some of the scanty figures supplied in the Commission's *Report* are compared; for when a series of relevant comparisons are made between the wages of similar workers in two countries—between a French and a Welsh puddler, a French and a Welsh roller, a French and a Welsh blast-furnace minder, etc.—they show no uniformity in the percentage variation. For instance, French and Welsh puddlers had a very similar wage in 1866, but in Wales a finishing roller

[1] *Ibid.* Q. 10,023. The pamphlet was *Handicraftsmen and Capitalists*, by H. H. Creed and W. Williams, 1867; republished from *The Times*. Williams in his tract gives so wide a range to his wage statistics that precise comparison is precluded; e.g. a roller's wages in Belgium vary from 4*s.* 2*d.* to 5*s.* 10*d.* per day, a blast-furnace filler's from 1*s.* 1*d.* to 2*s.* 1*d.*

[2] *R.C. on Trade Unions*, 1867, Qs. 8281, 9520.

[3] *Ibid.* Qs. 9127, 11,140 sqq.

had an average wage twice as high as a puddler: in France the advantage was slightly with the puddler.[1]

The *Report* gives a blurred picture of international wage comparisons, and it is not surprising that no bridge is provided from this to a comparison of labour costs. There was no reference to the possibility that the influence of high wages might be mitigated or wholly counteracted by the possession of better plant. Probably this was a reflection of the counties from which witnesses came. Most were from the older iron districts where recent changes in plant were slight. Of the exceptions the chief Welsh witness[2] had no fear of competition and no experience of foreign works (or, for that matter, of trade unions, though he opposed them); and the Cleveland witness[3] had only recently left Staffordshire. Most of the witnesses were talking of puddled iron, none in detail about steel. There were a few references to the relative efficiency of the workmen themselves, irrespective of the plant; but they were rhetorical, conflicting, and not statistical. Trade-union witnesses declared that foreign workmen in England found the pace much above the customary pace in their own country. "One Englishman does as much as two foreigners", it was asserted.[4] Williams thought the Belgian workmen were slower and less neat than the British, but that they worked more continuously, and thereby lessened capital costs.[5] An American ironmaster, giving evidence of French conditions, said that puddlers and rollers there did as much for their money as the Englishmen and Americans did for theirs; but he recognised the lack of any very satisfactory basis of comparison.[6] Charles Markham, of Staveley, who had run a works in France twenty years earlier, also equated the efficiency of English and Continental workers.[7]

But Markham, in an unguarded moment, added with some

[1] *R.C. on Trade Unions*, 1867, Qs. 9629 sqq. for France; Qs. 10,255 sqq. for Wales.

[2] G. T. Clark, Trustee of Dowlais. *Ibid.* Qs. 10,039 sqq.

[3] John Jones, Secretary to the North of England Associations of Ironmasters and Iron Manufacturers: *ibid.* Q. 9391.

[4] *Ibid.* Q. 9193.

[5] *Ibid.* Qs. 10,015 sqq.; and H. Creed and W. Williams, *op. cit.* p. 60.

[6] *R.C. on Trade Unions*, Q. 9282.

[7] *Ibid.* Qs. 11,668 sqq.

exaggeration that English iron and coal resources almost allowed double wages here in the iron industry. It was not so in engineering, where serious foreign competition was to be expected immediately.[1] But the evidence threw suspicion on the case that high wages were disturbing the English share of the international iron trade. There were other facts equally unfavourable to the ironmasters' case. "With respect to the probable driving out of the iron trade of England, have you seen the returns showing the amount of English iron which has been exported during the last year?" Tom Hughes asked of John Chambers, a South Yorkshire witness. "I have not noticed that."[2] The comedy repeated itself. Exports had, in fact, mounted from 1,683,000 tons in 1866 to 1,883,000 tons in 1867.[3] Possibly most of the witnesses had not felt any benefit from this, since the rise in exports was made up of iron rails and pig iron, which the Midlands did not supply for foreign trade. But they must have been aware—and some were induced to admit it—that the *malaise* of their industry was mainly accounted for by disturbances of the home market, in railway development and shipbuilding.[4] So while the proceedings of the Trade Union Commission left the international comparison of labour costs unadvanced, they also showed[5] that this comparison was of very uncertain relevance as an explanation of contemporary movements of trade.

[1] *Ibid.* Q. 11,669. [2] *Ibid.* Q. 14,610.
[3] Below, p. 20.
[4] *R.C. on Trade Unions.* Q. 9527 (J. Jones), Qs. 10,004 sqq. V. Williams).
[5] Perhaps not to all the Commissioners.

Chapter II

'LEAPS AND BOUNDS': AND REBOUNDS 1868–1879

By 1869, when Jordan's study was published, and the Coal Commission heard evidence on fuel economy, public interest in the problems of the iron industry had evaporated. The excitement of the two preceding years had been disproportionate to the immediate danger, and declined with the return of more prosperous business. The depression in the iron industry in 1866 had been due to a collapse of its internal trade—particularly to the drying up of the "home rail" demand. Although the consequent low prices probably resulted in a greater use of iron in England for bridges and buildings, it was an extension in the foreign demand for its staple product which refreshed the industry. Even in 1867 there were signs of increased activity in foreign railway construction; Russia doubled her purchase of rails to 115,000 tons, and an increase of 50,000 tons in the rail export to the United States reflected the impulse which the victory of the North had given to the building of the Transcontinentals; but prices were too low for anyone to sense a "revival" in this year. Within the next three years the American and Russian consumptions continued to expand, and, particularly from 1869, railway building was taken up extensively in a large number of other states. By April 1870 the *Iron and Coal Trades Review* had diagnosed a "mania". India, now that the State had railways in hand, was setting out on a new 10,000 miles; Canada as a result of Confederation had a modest 3000 mile programme; the United States had 15,000 miles more in view. Russia had placed orders in Cleveland to a value of three million pounds. Most Central and South-Eastern European states, partly under the stimulus of the Suez Canal, were either building or seeking the money to build new lines; and, like the

Russians and the Americans, they were often successful seekers in the London money market, which had recently grown fonder of loans to foreign states and investments in foreign railways since the disillusioning of home investors. South American states were also in the field as borrowers and builders, caught by the spirit (or the promoters) of development, and stimulated by cheap money and cheap iron.[1]

The railway programmes brought a vast increase of business activity to all iron-producing countries—precisely how much there are no consumption statistics to tell. They constituted the main factor responsible for a growth in world pig-iron production from 8·9 million tons in 1866 to 11·1 in 1869 and 14·4 in 1872.[2] By 1869 a wave of activity in the building of iron steamships set in, stimulated by competition on all passenger-carrying routes, and by the new needs created by the Suez Canal, which supplied a second factor encouraging to the iron industry, but one far less important than the railway demand.[3] Other branches of engineering than those related to railway or steamship work recovered only slowly until 1871–2 from the depressed conditions of 1867; with the exception, in some areas, of industries concerned with national defence.

Great Britain produced two-fifths of the additional output of pig iron, the United States about one-quarter, while Europe was responsible for the remainder—Germany leading. Thus, though Britain still produced, in 1872, 42 per cent of the total pig iron manufactured, world production was now growing faster than British; and this was true also of finished iron manufactures. In international trade, however, the domination of England was more than ever impressive. From 1866 to 1872 the British exports of iron (not including iron used in exported

[1] R. Giffen, *Essays in Finance*, 1st series, 1877, pp. 113–17, tells the story broadly. Also from a narrower standpoint S. Griffiths, *Guide to the Iron Trade* (1873), pp. 12–13, and *passim*. For details, the impressions of journalists and merchants, *I.C.T.R.* Nov. 24, 1869 (leader); Dec. 22, 1869, p. 721 (Shaw and Thompson's Circular); Jan. 12, 1870, pp. 23–5; April 27, 1870, p. 262; and *passim*.

[2] From *Statistics of the Iron and Steel Industry*, published annually by the British Iron and Steel Federation (formerly the Nat. Fed. of I. and S. Manufacturers).

[3] E.g. *I.C.T.R.* Jan. 12, 1870, p. 23; Jan. 3, 1872, p. 1; *Engineering*, Jan. 21, 1870, p. 38.

machinery) rose from 1·68 to 3·38 million tons, at the end of which the export amounted to 60 per cent of the total output, compared with 45 per cent in 1866. Compared with this export trade those of Belgium, Germany, France and the United States were insignificant.

The following table (Table I) illustrates both the expansion of export business and its relation to railway building. Exports of manufactured iron other than railway iron grew with relative slowness; and they included items connected with railways such as plate- and section-iron for bridges. The large pig-iron export was feeding in some degree Continental and American manufacturers of railway material—it is not possible to judge the degree. Exports of "old iron for re-manufacture" included rails, which sometimes, with no further treatment, were used again in the States, entering, however, at a low rate of duty.

TABLE I

British exports of Iron, 1866–1872. (In 000 tons)

	1866	1867	1868	1869	1870	1871	1872
Pig iron	500	566	553	711	753	1057	1331
Railway iron	498	581	583	888	1059	981	945
Other manufactured iron	668	689	713	850	796	990	999
Old iron	17	47	95	120	107	140	108
Total	1683	1883	1944	2569	2715	3168	3383

"Other manufactured iron" includes bar iron, sheets, plates, angle and section iron, wire, ingot steel and steel manufactures.

When the export trade was at its height, from 1870 to 1872, 46 per cent were taken by Europe, 30 per cent by the United States, 15·5 per cent by the British Empire and 6·5 per cent by Central and South America. The directions of rail exports show interesting divergences from these figures; United States consumption accounting for 52 per cent of the total, while Russia, with 13 per cent, took as much as the rest of Europe together and more than the Empire. Germany was the chief consumer of pig iron, followed by the United States and Belgium. The diversity of markets was remarkable, but it was significant that over one-half of the exports went to iron-producing areas.

The growth in iron production in the early 'seventies would have been outside the compass of existing plant, but prices and

prospects encouraged extensive additions to plants in many of the producing areas. America, Britain and Germany, in that order, were the most active seats of this development. For these early years there are no precise statistics for tracing movements in the productive capacities of ironworks and steelworks. A very rough index can be found in the number of blast furnaces. In the United States 150 new furnaces, widely scattered geographically, were built in the three most active years (1872–4) to add to the 570 furnaces which were in blast in 1871. The new furnaces were in many cases much more productive than the older ones. The most vigorous English districts were the relatively young coastal districts—North-East and North-West. There were about thirty new furnaces built in Cleveland between 1869 and 1874, probably adding above 50 per cent to the producing power of the area. In the hematite area of Cumberland and North Lancashire twenty-three of the 101 furnaces in blast in 1875 were new since 1872. There was some significant growth in other smaller districts. Lincolnshire, where the valuable phosphoric ores were just being tapped, increased its number of furnaces from seven in 1871 to twenty-one in 1875; Northamptonshire, also with phosphoric deposits, increased its ten furnaces of 1870 to eighteen in 1875; in Derbyshire the number rose from forty-three to fifty-one in the same period. In these districts the fears of foreign competition so vocal before the Trade Union Commission proved no check to expansion. The famous older centres, South Staffordshire, South Yorkshire, South Wales and Scotland, were less active in adding to plant, particularly to blast-furnace plant. In Germany the pace of blast-furnace construction appears to have been less than in England and the States, but there were several important new plants in Westphalia—at Mülheim, Ruhrort, Bochum and Duisburg—and in the minette districts of Lorraine and Luxemburg. Belgium and France also responded, in less degree, to the stimulus of the boom.[1]

[1] The *J.I.S. Inst.* includes records of the developments of the iron industry in England and abroad. In particular *J.I.S. Inst.* 1872, II, pp. 163–7; 1873, p. 196; 1874, p. 432; 1875, pp. 269, 321; 1877, pp. 472 sqq. Blast-furnace statistics do not always distinguish between new furnaces, and old ones brought again into use; on

In most districts additions to blast-furnace plant were associated with additions to plant for the later stages of the iron industry—foundries, forges, iron mills, Bessemer steelworks. Some part of this development was exceptionally speculative. It was in these years that the Bessemer industry and the malleable iron industry came to grips for the possession of the rail-making business. Demand for steel rails grew quickly, and encouraged widespread investment—in all the leading iron-making countries. There was still in the early 'seventies, however, a very active demand for iron rails, and this provided a stimulus for a great extension of forge and mill plant in the Cleveland district.[1] Other malleable iron districts, English and foreign, did not respond with any vigour to the demand of these years, though a little new puddling plant was put up in most. Cleveland iron-rail makers discussed the prospect that their manufacture would be "civilised off the earth"; they concluded, however, that the price margin between iron rails and steel, which was the determining factor in sales, was permanent, and that it was wide enough to ensure a big market for iron rails in new countries and for new lines where the weight of traffic would be light.[2] For the export business the district was admirably placed geographically, and the local ore and coke allowed exceptionally cheap production. There was a prospect that puddling would be mechanised and cheapened—a prospect encouragingly pictured by a Commission sent by the Iron and Steel Institute to report on an American invention in 1871.[3]

the other hand, when a new furnace took the place of an old one the figures often indicate no change, though the change might be important. It is believed the figures quoted give a reliable picture.

[1] Additions to puddling plant can be traced in the annual *Mineral Statistics* of R. Hunt. Practically every firm added new puddling furnaces in 1870 (cp. *I.C.T.R.* Dec. 28, 1870, p. 840: Review of 1870), and the same happened in succeeding years. Several completely new works were laid down, some specialised for rail-making (e.g. the Britannia Iron works, with 120 furnaces and an output capacity of 1200–1500 tons of rails per week: the chief partner was Sir Bernhard Samuelson).

[2] A discussion at the Iron and Steel Institute is reported in *I.C.T.R.* Oct. 1869, p. 222. The price of steel rails was then £9, of iron rails £6. 10*s*. J. T. Smith of Barrow said that the removal of Bessemer's royalty—of £1 per ton—in 1870 could not lower price. Cp. also *ibid.* March 23, p. 184 (leader).

[3] The invention was Dank's Rotary Puddler. Report in *J.I.S. Inst.* 1872, I, pp. i–xxxv.

English steelmakers held out no promise of lower costs, and the pig iron which was necessary for the Bessemer process, a pig iron free from phosphorus, was far more expensive than "forge pig",[1] and could only be made from a relatively small proportion of the world's ore supplies. Cleveland makers were no doubt influenced by the fact that their own ores were not among this favoured proportion; indeed only the West-Coast district in England had ores suited to the new steelmaking—hence its recent growth.

Alone among the Cleveland firms Bolckow Vaughan's, capitalised now by Manchester but dominated by Welsh technicians, sensed the future wisely in 1871 and determined to go in for steel.[2] It was true that the local ore which they had pioneered was not suitable; but ore could be brought from other districts. Two of the great South Wales ironworks—Dowlais and Ebbw Vale—had already shown in the 'sixties that this could be profitable. Barrow was poorly situated for the supply of fuel, hence even North-West Coast ore could be smelted profitably in Wales, where fuel was admirably cheap. The Welsh steelmakers had also found that Spanish ore could be used with commercial success.[3] The same plan must, it was clear, succeed in Cleveland. Bolckow's bought an experimental Bessemer plant in 1871 and started building the famous Eston works in 1874.[4]

The English steelmakers were not alone in becoming dependent for expansion at this time on imports of ore. Of the great producers only the United States could supply its own needs—though ore and coal were neither close together nor

[1] Some of the difference in price was due to the scarcity of hematite, but hematite ore was more difficult to mine and more expensive to reduce than the lias ores of the North-East. See later, e.g. Bk II, ch. IX.

[2] Bolckow was a German corn merchant in Newcastle and brought capital to the firm. (Obituary in *J.I.S. Inst.* 1878, p. 288.) Vaughan, the technical partner, was Welsh: the managers of the firm in the 'seventies were both Welsh: E. Williams (of Dowlais); E. Windsor Richards (of Ebbw Vale). For the Manchester capital cp. J. H. Clapham, *Economic History of Modern Britain*, II, p. 138, and below, p. 254. For steel policy, Report of the Company for 1871, *I.C.T.R.* March 29, 1871.

[3] Beck, *op. cit.* p. 908; Bell, *The Iron Trade*, p. 16.

[4] Report, *I.C.T.R.* March 5, 1875, p. 263.

well placed for export purposes. Belgium had no suitable native ores; French and German supplies were short, expensive, and not well situated. All three of these Continental producers began importing extensively in the early 'seventies: France from Algiers, Germany and Belgium from Spain.[1]

The great activity of these years reached its culmination early in 1872. Already in March of this year Giffen, the experienced statistical economist, sensed "a less prosperous period".[2] But in the industry itself no slackening of demand was felt; the habit of plant extension remained, and prices were rapidly increased. Prices in England, which largely determined world-price movements, had been raised gradually through 1869 and the early part of 1870, and had reached a satisfactory level for makers. A series of events then checked the makers in their desire to improve further on the position. The Franco-Prussian war disturbed both the rail market and the money market; Russia's denunciation of the Treaty of Paris caused a flutter after peace seemed assured; the *Alabama* dispute introduced an element of uncertainty into Anglo-American relations; and the French "reparation" loan raised fears of immediate dear money. When these fears were laid in the middle of 1871, and some demands, in particular from a Germany flushed with victory and with reparation credits, still grew, the ironmasters were able to obtain very high prices for new orders. Cleveland forge pig rose from 50*s*. per ton in September to 64*s*. in December, and Staffordshire "marked bars" from £9 per ton in September to £10. 10*s*. at the end of November. Then the pace quickened. Through the first six months of 1872 the pig-iron price mounted steadily to 110*s*., the bar-iron price to £16. Some prices rose with a more measured gait, and continued their upward trend after marked bars and pig iron had reached a maximum: iron-rail prices, for instance, rose until the spring of 1873.[3]

In May 1872 a prominent firm of iron merchants came into line with Giffen in prophesying that, despite the price move-

[1] Beck, *op. cit.* pp. 987, 1084. [2] Giffen, *op. cit.* p. 81.

[3] Griffiths, *op. cit.* pp. 18–21, and *passim*; *I.C.T.R.* Sept. 26, 1870, p. 416; Nov. 30, 1870, p. 777; Dec. 28, 1870, p. 840; Oct. 2, 1872 (leader); Dec. 18, 1872, p. 1016.

ments, and partly because of them, the period of prosperity was passing its height. Dear money had been delayed, but not for long; demand was within the capacity of existing plant; while the high level of prices, due solely to the rampant spirit of speculation, was a twofold evil, causing internal strife between the coal industry, the wage earners and the ironmasters, and stimulating foreign competitive development.[1] Part of these forebodings were manifestly true. Throughout 1872 several firms felt the burden of the internal strife; long contracts at relatively low prices had to be carried out at the contracted rates while the current iron prices mounted; coal prices and wages, however, moved in harmony with the current price. Coke, for example, in the North-East Coast rose from 10*s*. or 12*s*. per ton at the end of 1871 to as much as 40*s*. per ton in July 1872; and similar "famine prices" ruled in other producing districts. Wages rose with less *éclat*, but notably, the scale being represented by a movement of puddlers' wages from 8*s*. 6*d*. per ton to 13*s*. 3*d*. per ton; in Wales and Scotland the movement was accompanied by strikes and lockouts. During the same year the fever of plant extension reached its height abroad; in Germany, for instance, during 1872 thirty-six new companies for the manufacture of iron and steel were founded, out of a total of forty-two established between 1870 and 1874 whose capital amounted to sixty-one million thalers. The forecast rise in the price of loans came in the second half of 1872—the final factor in this being the demand for gold for the German currency plans, coming on top of an inflationary trend in all money markets.[2] An influence more immediately serious was felt towards the end of the year when the demand began to flag in some departments—in shipbuilding and in merchant iron. In the spring of the next year this was extended to railway material.[3]

It was at first supposed that consumption had fallen because of the high prices. Since the demand for iron had become so

[1] Shaw and Thompson's Circular. *I.C.T.R.* May 22, 1872.

[2] *Econ.* Jan. 4, 1873, p. 2–3, and its *Annual Commer. Hist. and Review*, March 15, 1873, p. 7.

[3] *I.C.T.R.* Oct. 2, 1872 (leader); June 25, 1873, p. 620.

widespread many persons had persuaded themselves that the periodic slumps which were a familiar feature of the industry in the past would never again recur.[1] But the illusion of large orders held in suspense till prices were more favourable was cruelly and continuously dispelled. The unsoundness of much of the railway development from the standpoint of immediate remuneration became evident; several governments, among them the Russian, Austrian, Turkish and Egyptian, began to find the burden of guaranteed interest on railway capital heavy; Indian railways were in difficulties accentuated by the "silver question"; and in 1874 only one-quarter of American railway capital returned any dividend.[2] In the circumstances the decline in the railway consumption of iron was for some years progressive. Even so railway growth had already advanced far enough to encourage the production and marketing, in 1873–4, of too greatly increased supplies of wheat (from Russia and the United States), and of cotton, with a serious price fall resulting.[3] Unfavourable commodity markets and unprofitable railways revealed financial weakness. The first of a series of crises occurred in Vienna in May 1872. Panic conditions rapidly followed in Russia, Germany and Italy, and in September the United States suffered most severely of all. Several South American States defaulted in 1874. London avoided any real crisis until 1875, but the money market became—in the customary jargon—progressively tight. By 1875 lenders were shy of "development", and prospects of a revived demand for iron receded.[4]

By the autumn of 1873, in response to market conditions, prices of most classes of iron were lowered; and this was the first stage of a period of almost continuous fall until 1879. The price of Scottish pig iron at Glasgow fell from an average of 116*s.* per ton in 1873 to 87*s.* in 1874, 65*s.* in 1875 and 46*s.* in 1879, lower than at any time since 1848. Cleveland iron which had sold at above 110*s.* dropped to 36*s.* 8*d.* at the end of 1879.

[1] The view was freely expressed in *I.C.T.R.* e.g. May 21, 1875, p. 500, and May 20, 1874, p. 572.

[2] C. E. Muller's Report for 1874, in *I.C.T.R.* Jan. 15, 1875.

[3] Giffen, *op. cit.* p. 116.

[4] *Ibid.* p. 109 sqq.

Wages moved similarly downwards, with singularly little "lag", in many cases falling back to the level of the previous crisis. Coal prices also dropped, though less precipitately at first. The movements reflected a deepening depression, general, though not uniformly injurious in all branches of the industry.

All leading ironmaking countries shared in the depression, as was natural, since all had responded violently to the stimulus of the unbalanced increase in the consumption of iron. There were, however, significant variations in the severity of the suffering of different branches of the industry in different centres, and it is important to trace these. In England the primary factor at the outset was the falling off in foreign demand, particularly in the demand for railway material. As far as can be judged by a comparison of pig-iron production, exports and stocks, the home consumption fell between 1872 and 1874 by about 5 per cent, and then rose by 10 per cent to a level which was maintained till 1878. 1879 witnessed a big fall—but the old position was recovered by 1880.[1] The change in exports is illustrated in Table II. How largely the decline in exports was concentrated in those groups which had participated in the boom may be seen at a glance. Exports of iron and steel not specifically for railway needs fell very little from their level in 1872.

TABLE II

British Exports of Iron and Steel, 1872–9. (In 000 tons)

	1872	1873	1874	1875	1876	1877	1878	1879
Pig iron	1331	1142	776	948	910	882	923	1223
Railroad iron	945	785	783	546	415	498	439	464
Other malleable iron	673	639	587	662	597	652	640	678
Other iron and steel exports	325	362	299	280	279	291	251	283
Scrap	108	60	43	22	23	22	32	235
Total	3382	2988	2488	2458	2224	2345	2285	2883

There was some reduction in exports in most directions, but the most dramatic change occurred in the trade with the United States. Rail exports in this case fell from over 500,000 tons in

[1] I. L. Bell, *The Iron Trade*, pp. 26 sqq.

1871 to nothing in 1876; and the total iron export from over 1,000,000 tons in 1871 to less than 200,000 in 1878. Next in importance to the falling off in American demand for English iron was the fall of German imports. England's export to Germany and to Holland (through which much English iron went into Germany) fell from over 800,000 tons in 1873 to 560,000 tons in 1878. No other variation in exports at this time was on a scale comparable to these.

As the depression continued a second factor became of great importance in England, namely the rapid transfer of demand from iron to steel rails. The transfer disturbed all rail-producing centres, English and foreign. But it was most serious in England. The English industry was bigger than its rivals; and it had recently expanded. Its position was also peculiarly sensitive, since so large a proportion of its product was made not merely for foreign use but for the use of countries themselves producing iron rails, notably America. American consumption of iron rails fell from 1,250,000 tons in 1871 to 470,000 tons in 1876; imports in the same period fell from 515,000 tons to nothing.[1] By 1876 it was recognised in England that the iron-rail trade was dead. Middlesbrough lamented that Tees' rail development had not all been in the same direction as Bolckow Vaughan's—"it was so easy to see that the tendency was to substitute ingot for piled rails". Welsh firms, with no other outlet, were still taking rail orders—at "losing" prices; Cleveland railmakers were refusing to do this and were trying to enter into the other local branches of the malleable iron industry—bar-iron manufacture and the production of girders and of angle iron and plates for ships.[2] The step only distributed the suffering more widely, since demand for malleable iron other than rails remained stationary.[3] The old-established Welsh makers largely withdrew from business in 1877 before their resources were dissipated,[4] but Cleveland firms (though not, it may be, the

[1] *J.I.S. Inst.* 1877, p. 261.

[2] *I.C.T.R.* Jan. 5, 1877, p. 7. Article from *Middlesbrough News*, with local statistics.

[3] *Ibid.*

[4] Letter of R. Crawshay (Cyfartha) in *I.C.T.R.* Oct. 17, 1877.

workmen) experienced more severe distress. By 1879 twenty out of the forty-four puddling firms of the district were bankrupt, owning 821 out of the total of 2158 furnaces. Among them was Hopkin Gilkes, famous as a producer of iron for shipbuilding, and a pioneer in mechanical puddling.[1]

For the English steel industry depression was far less acute than for the malleable ironmakers. Competition, both internal and foreign, became an important factor, and quasi-monopoly gains ceased. Plant improvement became imperative.[2] But markets (and production) grew continuously in the decade, though prices fell.[3] Hence in the worst years of the depression productive capacity was increased.[4] Some of the older firms were severely distressed, Ebbw Vale in particular.[5] Some found it necessary to turn from their original speciality to a new one, e.g. John Brown's from railmaking to the production of more refined products for which their locality was better suited.[6] But for the steel industry as a whole the period was difficult but not disastrous.

English ironmakers were alone among the chief producers to suffer no serious contraction in the home market of their industry.[7] In the United States there was a considerable decline in consumption after 1873.[8] The high tariff made it possible, however, for the finishing branches of the industry (the makers

[1] *J.I.S. Inst.* 1877, p. 478; 1879, p. 545. Hopkin Gilkes was greatly damaged by the Tay Bridge disaster; the firm had supplied the iron.

[2] Below, chapter IV.

[3] There was a rise in steel output every year of the 'seventies. In 1869 £9 per ton for steel rails had been regarded as very low. Prices rose in the boom. In 1878 sales at £5 per ton were frequent.

[4] New plants or big extensions were made by the following companies between 1876 and 1879: Bolckow Vaughan's, the North Lonsdale Iron and Steel Co., the West Cumberland Iron Co., the Moss Bay Co., Brown, Bayley, and Dixon's, Steel, Tozer and Hampton, the Rhymney Iron and Steel Co.: *J.I.S. Inst.* 1877, pp. 474, 479, 492; 1878, p. 545; 1879, p. 564.

[5] Ebbw Vale suffered from strikes at home and civil war disturbed ore properties in Spain. Probably there were faults of management. Losses had amounted to £670,000 by 1877. Cp. *I.C.T.R.* 1875, p. 802; 1877, p. 518.

[6] *J.I.S. Inst.* 1889, I, p. 44.

[7] If the products of the industry are treated as homogeneous—which is convenient though it may become misleading.

[8] The American position is well summarised in *J.I.S. Inst.* 1877, pp. 253–71.

of rolled iron and steel) to avoid serious reductions of output, though the pig-iron makers were less happy. The equable output of rolled iron and steel, with steel gaining, was maintained by, or at any rate accompanied by, very severe price reduction; prices of most products were down by 50 per cent or more by 1876. And even steady consumption did not fill works "to capacity". But the position was certainly rather less disturbing than in other producing centres, and favoured an earlier recovery.

Germany was at the other end of the scale—most disturbed of all. She suffered from an accumulation of misfortunes. The acquisition of Lorraine had brought a new home-producing area into competition with the existing ones; for the newly German territory found its old French markets unfavourable.[1] Tariff policy, moving more and more towards the English pattern, brought abolition of duties on iron just in the years when world prices were tumbling and markets hard to find, particularly for England.[2] And when steel prices through the increase in the world's productive capacity bore a closer relation to costs of production, German disadvantages with regard to ore supply had painful repercussions. Not only were steel-rail costs relatively high, and competition therefore difficult, but it was often more attractive for steelworks to import English hematite pig than to use native iron, even of their own making.[3] These factors coincided with an extremely sharp contraction in the German use of iron. Figures reducing German consumption of iron to a pig-iron basis show the severity of this, a consumption of nearly 3·0 million tons in 1873 falling to 1·75 million in 1876 and 1·5 in 1879.[4] Such a contraction could not have been compensated for even by a complete cessation of imports; and tariff policy gave no opportunity of restriction of imports such as occurred in the States. Possibly these two circumstances combined to promote the last, and in some ways the most

[1] Report from *Cologne Gazette* in *J.I.S. Inst.* 1875, p. 288.
[2] *Ibid.* and F. Kestner, *Die deutschen Eisenzölle*, 1879–1900, pp. 1–3.
[3] Cp. *Consular Report* of E. Crowe, Düsseldorf: 1876, LXXV, p. 513.
[4] Kestner, *op. cit.* p. 132.

remarkable, feature distinguishing German from both American and English development, namely, a very considerable growth in export trade, even in steel rails. Exports were trebled and rose to above 700,000 tons in 1878; imports fell by one-third.[1]

German exports now quite outdistanced those of Belgium. But Belgian foreign trade fared better than British in the depression; it continued to rise in 1874, and its falling off after that year proved shorter-lived than the falling off in British exports, since in 1878 the level of 1874 was reached again.[2] Hence the Belgian industry remained in English eyes significant and rather sinister; very lightly protected by tariffs, yet placing half its product of manufactured iron and steel in foreign markets.

Watching the growing relative importance of these foreign exports in the mid-'seventies, British makers were impelled to take a second step in national organisation. In the late 'sixties they had seen the value of pooling some of their technical knowledge. Now they observed how in the United States, in Germany, Belgium and France there were associations busily occupied in keeping members posted up with international events of significance for their trade. "Was it not requisite", asked the leading trade journal, "that British makers should form themselves into a special organisation for dealing with commercial subjects of imperial importance?" "A proposal", it added, "was brewing."[3] Early in 1876 the chief makers met "to organise united action and the acquiring of such general information as was for the common good". "The manufacturing", so the chairman of the meeting, G. T. Clark of Dowlais, averred,

[1] Kestner, *op. cit.* pp. 123–6. The severity of competition in Germany may be judged from the fortunes of the chief companies. *J.I.S. Inst.* 1877, II, p. 223, gives a list of the twenty-two chief German firms who published accounts, with their dividends from 1874 to 1876. In 1874 eleven paid dividends ranging from 6 to 20 per cent; in 1875, six paid dividends—only one over 7 per cent. In 1876 only three paid dividends, and of these one paid only 1 per cent. The position was worse till 1879.

[2] Belgian exports rose from 237,000 tons to 277,000 between 1873 and 1874; they fell to 220,000 in 1875, but were back to 273,000 in 1878. They continued to rise. Cp. *J.I.S. Inst.* 1875, p. 590; *Report of British Iron Trade Association*, 1880.

[3] *I.C.T.R.* Nov. 26, 1875, p. 1445.

"has far outstripped what may be called the commercial and legislative divisions of the trade." The contingent from Cleveland ("that Middlesbrough lot")[1] probably hoped to bring wage problems within the scope of a national association,[2] and advocated Boards of Arbitration; but here they failed, Lancashire and South Wales (a low-wage district) being firmly opposed. But the collection of statistics and the organisation of collective representation of the industry in its relations with the government were agreed upon, and the British Iron Trade Association was formed.[3] Narrow and ill-defined in its objects, timid in its concessions to the claims of organisation, imperfect in operation within its limited sphere,[4] it was the chief symbol of a recognition throughout the industry in the 'seventies of the changing face of world trade.

[1] The phrase is said to occur in the minute-book of one of the national associations in the industry.

[2] *I.C.T.R.* Oct. 22, 1875, p. 1445, remarked on the value of a strong union in the industry, as a means of securing uniformity of wages in all areas. The inspiration of this paper came from the North-East.

[3] Its first discussions are reported, *I.C.T.R.* Feb. 25, 1876.

[4] It is stated on good authority that its methods of collecting and handling statistics were rather chaotic, and the method of presentation lends support to this view.

Chapter III

COMPETITION AND THE CRISIS OF THE 'SEVENTIES

Interest in comparing the iron-producing capacities of different countries revived with the return of declining prosperity. For the aspect of the international iron trade was as disturbing to English observers in the later 'seventies as it had been flattering at the beginning of the decade. When the English position in American and German markets weakened while the only tariff changes were favourable, more still when Continental producers—Germany most of all—increased their export trade considerably when world exports were shrinking, questions bruited in 1867–8 regained publicity. Had the hand lost its cunning? Were the "hands" expecting too much?

Most of the leaders of influential opinion, including some in the industry itself, were inclined to treat these problems (raised not alone with regard to iron) as of at least only secondary importance in the economic situation.[1] They were broadly agreed as to the main cause of the long period of depression. The iron and steel industry in the first place had responded too fully to the stimulus of unwise investment in capital goods, particularly in foreign railways. The "leaps and bounds" of 1870–3—described by Disraeli in 1879 as a "convulsion of prosperity"—led naturally to world-wide collapse. Occurrences of this type were normal and recurrent. On this occasion distress was accentuated by the abnormal internal competition in the industry, between steel and malleable iron, and as a result of this among the makers of malleable iron themselves. This internal competition went some way to account for the long

[1] E.g. Giffen, *op. cit.* pp. 113–50, esp. 149–50; *The Times*, e.g. leader of April 14, 1879; Disraeli, in a debate on Protection, reported in *The Times*, April 30, 1879; John Morley, in *Fortnightly Review*, 1878, I, p. 548; Jeremiah Head, in *Proc. Cleveland Institute*, 1878–9, p. 68.

continuance of distress which popularised the view that this was no ordinary depression. But ironmaking, it was clear, suffered not only from its own disorders, being disturbed, with other industries, by harvest failures, by the threat of war, and by credit and currency conditions. The shrinkage of credit whose beginnings have been marked was prolonged; due in part to a lengthy series of commercial scandals, to which the iron industry supplied its quota.[1] More fundamental, it was observed that the supply of gold was becoming proportionately less for the needs of trade; partly because of Germany's adoption of a gold standard and the United States' return to specie payments, and partly because the annual increment to the world's supply was shrinking. Some of the sensational fall in iron prices, a fall shared in a less degree by other wholesale prices, had almost certainly to be attributed to this situation. Bimetallism became a fashionable creed; and Giffen speculated on reforms, such as a return to £1 notes ("worse than useless", the *Economist* thought), which would be possible "if bodies of men were amenable to reason in currency questions".[2]

Nevertheless, by the side of unwise speculation, changing processes and gold appreciation, it was recognised by all that foreign competition was playing a larger part than in earlier depressions. It was, however, very disputable how far this showed any infirmity in the English industry. The biggest change statistically—the building up of the American industry behind the tariff, which seemed to have deprived England of one of her best markets—had no such bearing. And, what was very important in the pragmatic air of English politics and economics, to most people it was not remediable. To a few "insignificant" persons occurrences of this kind warranted a change in British fiscal policy; tariffs for bargaining should be used to lower the barriers to British trade. But since only duties

[1] The most serious instance within the industry was revealed by the failure of the Plymouth and Aberdeen Iron Companies, which it appeared had been "virtually bankrupt for 25 years": *I.C.T.R.* June 4, 1875, p. 679, and *The Times*, leader on "Failures in the City", June 1, 1875. Several instances of dishonest company flotation were brought to light in these years. Below, Bk II, ch. XI.

[2] Giffen, *op. cit.* p. 346; and *Econ.* Jan. 25, 1879, p. 90.

on wheat, raw cotton or tobacco could possibly influence the United States, the suggestion of a policy of reciprocity was easily ridiculed. "We do not argue the doctrine of free trade", said *The Times*; "we do not argue that the world is a globe."[1] Orthodoxy, political and economic, expected the iron industry to discover new markets to replace the old.

On a smaller scale than the competition behind tariff walls, there was competition more fundamentally significant—met with in neutral markets or in Britain itself. Though small, it was persistent and growing. It came wholly from the Continent. Some of it could be accounted for by geographical factors: there were old British markets better situated for a Belgian or a French or a German industry when there was one. But not all could be explained this way. Yet the tempting deduction that it was to be explained by relative cost advantages was made difficult by the distress of the competing industries; a distress which in Germany was blamed largely on the British producers. Thus circumstances gave some reason for the assumption that competition was, in fact, "merely the search for markets which occurs in every time of depression".[2] Sales were made "below cost" rather than that the works should stand idle. It is quite certain that this entered into the situation. German ironmasters giving evidence before an official committee of inquiry, the Eisen-Enquete-Kommission of 1878, which was examining the case for renewed and increased protection, agreed that they had sold steel rails extensively for export in recent times at rates far below the home prices and far below the total cost of production; in one case it was believed below the "prime cost" of materials,

[1] *The Times*, April 30, 1879: a leader on the advocacy of Protection by Lord Bateman in the House of Lords: "The noble reasoner is content to remark that he had never understood that a country's prosperity could be measured by its imports, and he appeared to believe that in saying that he never understood a proposition he refuted it. Tried by this test the world's knowledge would be reduced to very limited proportions." The most illuminating of *The Times*' leaders on protection in this period may be found in the issue of Jan. 21, 1879: "There never was a time when protection did not hinder us... there never will be a time when Protection or Reciprocity would not have similar disastrous consequences." Also June 23, 1879: "Ministers have rejected all suggestions in favour of a reactionary economic policy", and Aug. 20: "A time of stagnation is the opportunity for fools."

[2] Giffen, *op. cit.* p. 126.

and wages, without reference to "overheads".[1] Big differences between the home and export prices of French and Belgian firms were also traceable from contracts, and were susceptible possibly of the same interpretation.[2] To sell at prices which did little more than cover prime costs was notoriously the practice of the English ironmakers; the Germans were thus following a familiar precedent, without any appreciable aid from fiscal policy.

If reliance may be placed on contemporary published estimates of costs, the geographical and "sales below cost" explanations of foreign success were more applicable to the competition in the new trade—steel rails—than in the old malleable-iron trade. In the steel industry Britain had a great initial advantage both in the possession of good home supplies of hematite ores, found near the sea, and in her situation and facilities for importing Spanish ores relatively cheaply and smelting them at coastal works. Continental works, forced to depend mainly on imported ore, were clearly not as well placed to do so as the British works. The Germans had deposits, but they were some distance from the coal measures, and dear to work, and neither so pure nor so rich nor so extensive as the British ores.[3] Belgian firms, near Liége, had to pay over 2*s.* a ton to bring Spanish ores from Antwerp: and German firms paid rather more to bring it from Rotterdam to the Rhine ports, such as Ruhrort, and 2*s.* again to bring it to Dortmund or

[1] The *Protokolle der Eisen-Enquete-Kommission*, a volume of over 800 double-column pages, is the best contemporary record for the history of the German industry at this time. It is composed almost wholly of evidence given by the chief makers and merchants, and includes a great mass of statistical information on costs, prices, wages, freights, etc. The fullest discussion of the rail price and cost problem occurs in the evidence of Herr Baare of the Bochumer Verein, pp. 779 sqq. In 1878 contracts to export were taken at 115 Marks per ton, though the firm estimated its total cost at 130 Marks (pp. 780, 796–7). Hoesch sold to North Italy at a price o 104 Marks per ton; he himself would have said this exceeded his prime costs (p. 232), but his competitors doubted it.

[2] E.g. *P. d. Eisen-Enquete*, p. 797.

[3] Even some plants not close to the Rhine, e.g. at Bochum, etc., used much imported ore. The native ores were in Siegerland, Nassau, and the Harz. Their iron content averaged about 48 per cent, against 56 per cent for the Spanish ore. Transport cost to the works varied from 4*s.* to 6*s.* 6*d.* per ton, and costs of extraction were high, e.g. the labour cost was 7*s.* 6*d.* in the Harz. Some of the ores had to be calcined. *P. d. Eisen-Enquete*, pp. 66, 389, 780.

Bochum.[1] Several Middlesbrough firms had no freight of this kind to bear, and in Wales it only amounted to 1*s*. a ton of ore. It appears, moreover, that in the 'seventies the sea freights from Bilbao to British ports were far below those to Continental ports; and South Wales certainly had an advantage owing to its coal export—the ore ships had return cargoes immediately available.[2] Hence in the 'seventies British works may have obtained their imported ore for 6*s*. or 7*s*. a ton less than it cost in Germany. No probable difference in labour costs, which for a ton of rails was at most between 25*s*. and 30*s*. from the stage when ore and coke had been assembled,[3] could compensate for this initial handicap of German producers: the conclusion was undisputed. It was likely that in time the handicap would be less, that the sea freights to British and Continental ports would more closely approximate, but even this would leave British plants with an advantage of 2*s*. per ton of ore, which meant 5*s*. or more per ton of rails.[4] And the Belgians had a further marked raw-material disadvantage, since their coal was poorer and more expensive to mine than the British.[5]

While, by the developing demand for non-phosphoric pig for mass-production steelmaking, England's superiority in resources was newly buttressed, in the older branches of the iron industry the trend was unfavourable. For the phosphoric ores of Lorraine and Luxemburg which were being opened up far more extensively now by German, French and Belgian ironmasters were for the most part less costly than the Cleveland ores which were the basis of England's cheapest forge pig. Much of the "minette" ore could be obtained in open workings exceptionally cheaply —the Cleveland ore all had to be mined—and the ore was often

[1] *Ibid.* pp. 6, 392, and Bell, *Manufacture of Iron*, p. 660. Bell gives the cost in Belgium as 2*s*. 4½*d*. by water, 3*s*. 6*d*. by rail.

[2] Evidence in the *P. d. Eisen-Enquete*, pp. 6, 791, gives the freight from Bilbao to Rotterdam as 13*s*. 6*d*. when the freight to South Wales was 7*s*. to 8*s*. 6*d*., to Barrow 10*s*., to Middlesbrough 9*s*. 6*d*.

[3] Below, pp. 106, 124.

[4] Bell, *Manufacture of Iron*, pp. 473–4, thought the margin in favour of Britain was still 6*s*. or 7*s*. per ton of pig iron in 1882; he was usually well informed on these points.

[5] *Ibid.* p. 630. The average output of a Belgian miner was 158 tons per year: in Durham it was 356.

self-fluxing and easily reduced; a quality which helped to diminish the seriousness of the disadvantage attaching to the distance of the ores from good coke. In the southern part of the deposits most badly situated for fuel it was possible to bring the best coke from Westphalia, adding a transport cost of 10 Marks to its original price of 8 Marks, and still have a cost of assembled materials for forge iron lower than the Middlesbrough cost.[1] (Perhaps not lower than the North Lincolnshire cost, where not dissimilar conditions prevailed.) The Continent thus had a slight raw-material advantage compared with the established English centres of forge-iron manufacture so long as transport expenses for export are neglected. But the raw material concerned was of no use for steel.

On these broad aspects of the competitive situation there was no room for discord. Information on the subtler aspects of the situation is necessarily of a far more speculative value. The late 'seventies are, as it happens, rather richly supplied with estimates of costs, often alleged (probably rightly) to be book figures, published by ironmasters with a view to the institution of international comparisons. A remarkably comprehensive series of figures was collected from German ironmasters by the tariff inquiry of 1878, including some data collected in visits to English works. And Bell, who, having deprecated the respect paid to foreign competition in 1867, never ceased diligently to measure its extent, was very active collecting comparative data, much of it from personal visits to foreign works where observation could help to check the confidences of the staff. Most of the figures do not relate costs to the scale of production or to variations in business activity, and for this reason alone cannot be pressed into very exacting service. But they deserve some reference, since, in spite of opposed prejudices in those who published them, they present a rather uniform cost picture,

[1] *P. d. Eisen-Enquete*, pp. 51–60, evidence of de Wendel: and below, pp. 155–8. The forge iron made was not exactly the same quality as Cleveland III, which was a foundry iron: de Wendel's costs for foundry quality were higher than for forge. But de Wendel, who knew English conditions intimately, believed that his forge iron was definitely cheaper to make than any forge iron made in England (p. 53).

although the factors controlling the costs—labour and plant efficiency—are differently assessed.

It was common ground that although the average wages paid to English blast-furnace workers were much above the German level,[1] the labour costs in Germany approximated to the Clarence cost for forge qualities, but were higher for Bessemer pig. Thus the German disadvantage in Bessemer iron was accentuated, the advantage in cheap forge iron maintained. Clarence labour costs, the standard by which the Germans measured their comparative standing, were 4*s*. 3*d*. per ton in 1877 and probably rather less than 4*s*. in 1878.[2] They were probably as low as any English costs; much lower than that in the older English districts, in which the Germans showed no interest. De Wendel made forge pig in Lorraine at a labour cost of 4 Marks per ton in 1878 from an ore not unlike Bell's, and the Rheinische works, using a better ore, worked at 3·63 Marks.[3] The Bochum works gave the lowest German figure for Bessemer iron, 4·86 Marks compared with 4*s*. at a Cumberland works.[4] There were considerably higher figures given in both countries.[5] It would be tempting to generalise that the efficiency of English labour, particularly in the heavy manual work, compensated for its additional cost, but the complex nature of any comparison, due to variation of the weights and physical nature of the ores charged in different plants, differences in equipment and routine, differences in the time of reduction and the quality of product, make any quantitative deduction of this kind impossible. The trend is clear. The British workman was better fed. Bell had discovered the large slice of truth there was in Brassey, and the Germans were apprehending it (at least in claims for tariffs).[6]

[1] The average wage per shift at a new blast-furnace plant at Mülheim was 2·6 Marks/day in 1878; at another at Bochum 2·9 Marks; at a third at Ruhrort 2·36 Marks. Bell's average for 1878 was 3*s*. 8*d*. In South Wales it was 3*s*. *P. d. Eisen-Enquete*, pp. 6, 369, 784, and below, p. 122.

[2] *Ibid*. p. 784. Bell published detailed figures.

[3] *Ibid*. pp. 10, 52.

[4] *Ibid*. pp. 781–4.

[5] But the range of the German figures was considerably the higher.

[6] Bell, *Manufacture of Iron*, p. 497, and *P. d. Eisen-Enquete*, p. 7: "German wages cannot go lower. ...The workman is now insufficiently fed.... Any traveller in England seeing the English food consumption realises that the German capacity must be less", and similar evidence on pp. 372, 785.

They also stressed the injury done to their labour supply by the three years' compulsory military service; when the men returned they not only needed re-training, but were temperamentally ill-adapted to the work; "sie haben den Stolz des preussischen Soldaten, und das ist ja auch sehr gut und patriotisch, aber für uns sehr kostspielig."[1]

In the later stages of production labour-cost advantages, according to the ironmasters, were mainly with the Continent. In the manufacture of puddled iron the Continent gained: first, in the puddling itself, not so much because the "first puddlers" earned a lower day-wage than in England—often there was very little in this—but because the work was differently arranged; the Continental puddlers often had two low-paid helpers, instead of one as in England, and they had a considerably larger output per furnace. Moreover, the composition of their pig irons favoured a high rate of output.[2] Thus labour costs per ton were lower, and capital costs as well. "Shingling" costs in Europe were lower because of the remarkably high rates of English pay.[3] Bell thought that in "merchant iron" rolling mills the cost advantage was at times with England despite some quite exceptionally high wages; he explained it by the greater capacities of English plant, and thought it transitory.[4] In steel-rail making the German ironmasters claimed that they worked both in the converter stage and in rolling more economically than the English. They recognised a handicap in their relatively small outputs; Phoenix made 25,000 tons in 1877–8, Hoesch 31,000 tons, Bochum possibly rather more. They would probably have estimated their capital costs as higher than the English, their wage cost and their fuel consumption less. Hoesch thought their wage-cost advantage was partly due to the vexatious character of the English labour supply; but they emphasised their "more rational" and more uniform working, with fewer "wasters" produced.[5] Bell agreed that their labour

[1] *P. d. Eisen-Enquete*, pp. 14, 801.
[2] Bell, *Manufacture of Iron*, p. 527.
[3] *Ibid.* p. 531. For the nature of shingling, Appendix I.
[4] *Ibid.* pp. 530–5.
[5] *P. d. Eisen-Enquete*, pp. 18, 234.

costs were below the English, but thought that English plant helped to reduce the margin between average wages and average costs: he gave as a representative comparison the instance of two works in which the German wage average in the converting shop was 43 per cent of the English, but the labour cost 62, the corresponding figures in the rolling mill being 63 and 85.[1]

The statement of costs (or pseudo-costs) gave no support to the view that, in the immediate crisis, wages disproportionately high for prices could be held at fault for the difficulties of the iron trade. Wages had moved, both in the iron trade and the closely associated coal trade, with admirable plasticity in harmony with prices. The sceptics (among them Giffen at the Board of Trade), who regarded the propagandist association of high wages and foreign competition as a scare which masked bad speculation or bad management, were in a measure right. Transport costs on coke or ore, and transport costs to ports for shipment, burdened Continental competitors more than enough to dissipate any advantages they might have in cheaper manufacturing costs; save for inland or high-cost centres of the English industry, like Sheffield for steel-rail exports, or Staffordshire, which could not except in specialities or for a local market stand even the home competition. In the game of losing prices which was being played, the English makers, especially the steelmakers, should win.

If the cost information were used to give light not on the immediate crisis but on a more distant prospect, it was less reassuring, since the English initial advantage would be at least greatly reduced should phosphoric iron become available for

[1] Bell, *Manufacture of Iron*, pp. 535–8. Detailed specific costs on which a comparison of this kind might be based are not available: but details given by German firms are of interest. The labour costs at the Phoenix works were given as 6*s*. 6*d*. per ton of Bessemer pig iron, 5*s*. per ton of ingots, 8*s*. per ton of rails in the mill. Other makers' figures were fairly similar, though at Bochum the figure for ingots was 3*s*., at Maximilianshütte, 6*s*.: at the latter works mill costs were 10*s*., while Hoesch said his total cost from pig iron to rails was only 8*s*. (*P. d. Eisen-Enquete*, pp. 10–11, 232, 750, 781.) It may be that in some instances at least maintenance labour cost was excluded. Bolckow Vaughan's total cost in the steelworks at Eston was given in an Arbitration as 8*s*. per ton of rails in 1877; compared, it may be noted, with 28*s*. for a ton of iron rails. *R.C. on Labour*, 1892, Evidence of Trow, Q. 15,165. The problems of cost are discussed more fully in subsequent chapters.

steel, and when that occurred it would be more vital that technical and managing skill and labour efficiency should fully compensate for high wage rates. But there was much to suggest in the 'seventies as in the preceding decade that the compensation was far from complete. How much so it is the purpose of the next chapter to show.

Chapter IV

ENGLAND AND THE ADVANCE OF TECHNIQUE 1870–1878

"So far as skill in the conduct of the various metallurgical operations themselves is concerned, I have never heard it pretended, and I have failed to discover, any superiority in the practice of foreign manufacture over ourselves."[1] Bell in the early 'eighties stuck to his thesis of fifteen years ago. But it was the opposing view which gained ground in the decade after the Paris Exhibition, if the bias of leader-writers may be taken as a guide; the view that technical leadership in the industry had ceased to be an insular monopoly, and that in some directions the British makers were falling behind.[2] It was right that the less complacent view should advance. The picture of the industry given in the official inquiries and expert surveys of 1867–8 was necessarily an impressionist sketch, catching the emphasis of passing conditions of light and atmosphere. But a growingly rich technical literature from 1869 (when the *Journal of the Iron and Steel Institute* began to appear) shows that the critics of these years, albeit perhaps over-emphatic, had apprehended a real trend in the industry. The ten years after the Exhibition were characterised by no dramatic inventions, but by the continuous cumulative improvements which Bell rightly stressed. In these years American and Continental competitors were making novel advances in most branches. Some of the innovations quickly made their way in England: in all likelihood England learned

[1] Bell, *Manufacture of Iron*, p. 582.

[2] E.g. *Daily News*, June 19, 1876, leader on the Iron Trade. The *Daily News* sent a commissioner to all the chief iron districts at the period. With regard to new processes the leader concluded that "our foreign rivals are quite equal to us in discovering such aids and utilising them". Also *The Times*, May 28, 1875: "The iron trade must make an effort to keep pace with production elsewhere." *The Times*, it is interesting to note, relegated the industry to the fourth leader.

more than she taught. There were other departures from established practice not immediately acceptable to the English producers. It is arguable of a few, without sophistry, that they were the natural products of other environments which gave a value lacking in England to the half-ripened fruits of early experiments. But the measure of this is not large in a survey of the whole.

When Bell addressed the British Association, Cleveland was undoubtedly the most progressive district for the mass production of cheap pig iron, and leader in all recent improvements save the utilisation of gas. After 1870 the best Cleveland practice tended to become stationary,[1] and interest centres for some years on the advance of average practice nearer to the best. (It was a district of young men, but two grey heads had appeared by 1875;[2] probably more by 1878.) Cleveland makers had aimed at increasing output by increasing the height of furnaces, and at saving fuel by raising the temperature of the blast. Since it was discovered that height also led to fuel economy, coke consumption became the main criterion of advance. Greater height of furnaces had necessitated an increase of hearth diameter and a slight increase of blast pressure, but these changes were subordinate.[3] By 1870 increase of height had been carried to a point where further changes proved a diseconomy; and the culminating improvement to blast-heating apparatus, the epoch-making introduction of the fire-brick stove, had been made; though it remained the subject of controversy, Bell discounting its economy first on account of real but not insuperable practical difficulties, and later for supposed (but erroneous) scientific

[1] *J.I.S. Inst.* 1879, p. 9: "During the (last) ten years there was not much alteration or improvement in this branch of manufacture" (Ed. Williams, President); and Windsor Richards, to Cleveland Institute of Engineers: "latterly few improvements have been made", quoted in R. Meade, *The Coal and Iron Industries of the United Kingdom*, p. 396.

[2] *I.C.T.R.* May 21, 1875, quoting a letter in *The Times* to the effect that "scarcely a moneyed man had come into the district, and it is a curious fact that, except two, there is not yet a grey-haired man in the iron trade of Middlesbrough, Stockton or Hartlepool. Profits have been invariably spent on additional works".

[3] The technical journals contain many discussions of these problems in the 'seventies, to which later references will serve as a guide. Cp. also Bell, *Manufacture of Iron*, *passim*.

reasons.[1] With their attention focused on these two elements of blast-furnace practice, and perhaps with a tendency to place economy in coke consumption on too isolated an eminence, the progressive ironmasters of Cleveland failed to experiment seriously in these years in other elements of blast-furnace work; so that, apart from the adoption of a German system of slagging (with Bell again, characteristically, in opposition),[2] the form and proportions of the best blast furnaces remained little changed in the decade.

No other English ironmaking centres succeeded to Cleveland's position as pioneer: those centres whose practice changed were for the most part occupied in adapting Cleveland's advances to different ore and fuel conditions. The process made good headway in the hematite district, after some ill-contrived early experiments,[3] but in the other centres of the industry, new and old, the pace was slow. In most of them the use of the blast-furnace gases became far more widespread, under the stimulus of the coal "famine"; but the mode of collection adopted was normally the wasteful "open top" method (long driven out of Cleveland), whereby only part of the available supply was obtained, at times insufficient for the blast-engine boilers.[4] Most of the districts (but not South Staffordshire) could show isolated examples of tall furnaces working economically,[5] local difficulties having been overcome; and fire-brick stoves were making an equally sporadic appearance, also successful in saving fuel.[6]

In Europe blast-furnace advance followed English lines; new furnaces were often admirable examples of the Cleveland type,

[1] *I.C.T.R.* Dec. 28, 1870, p. 840; *J.I.S. Inst.* 1872, II, pp. 185 sqq.

[2] *I.C.T.R.* Nov. 10, 1869, p. 630, and Oct. 1875, p. 1202. Bell resisted the change till 1875, and then made it badly. Williams said Bolckow's refrained because Bell failed. *J.I.S. Inst.* 1875, pp. 444, 448–9.

[3] Discussion in *J.I.S. Inst.* 1871, pp. 408 sqq., and 1876, p. 40.

[4] Discussion in *J.I.S. Inst.* 1875, pp. 164–8. The Staveley works "had the most economical result by using the gas simply for the stoves".

[5] *Ibid.* 1875, p. 166; and Whitwell, *ibid.* 1878, p. 204: for Scotland, North Staffordshire, Derbyshire and Salop. The changes were permanently successful.

[6] In 1882, 112 British furnaces out of 968 (not all in blast) had Cowper or Whitwell stoves. Forty Scots furnaces in blast were not at this date using their gas at all. J. S. Jeans; *ibid.* 1882, pp. 135, 142.

working at times with an economy surprising to the Cleveland makers, but incorporating no striking novelty.[1] In the United States it was different. For here it was noticed that in the great expansion of ironmaking, while the average practice remained below the English level, some of the new furnaces were obtaining outputs bigger than any normally obtained in the best English plants, and were doing this not merely because of favourable ore conditions, though these helped, but by innovations in method. Primarily the change came through the employment of a much higher blast pressure—in 1874, 8 or 9 lb. instead of the English level varying from 2 to 5 lb.—whereby a greater volume of air was brought in contact with the charge in a given time, and a greater amount of the charge could consequently be "reduced".[2] Increase of pressure was followed by an increase in the size of the hearth, a necessary complement which allowed a greater volume of material to descend to the most intensely heated part of the furnace. These changes were not favourably viewed in England, since the life of the furnace lining was reduced considerably (the time life, though perhaps not the tonnage life), and they were admittedly accompanied at this date by an increased rate of fuel consumption. But there were compensating reductions of capital and labour cost, the latter perhaps of greater importance in the States, since labour was dear and fuel cheap. One change in American practice attracted a more favourable judgment from a distinguished Cleveland ironmaster, Thomas Whitwell, who commended the adoption of "the better plan" of supplying the blast to each furnace from a separate blowing plant, instead of using a common "main" to supply the air to a group of furnaces. The separation (which Whitwell found spreading in Europe as well as in America) allowed a much better control of the conditions of individual furnaces, and made more regular working possible.[3]

American blast-furnace advances had little or no immediate

[1] Cp. Schlinck, *J.I.S.Inst.* 1880, p. 539. For excellent Belgian and German results, *ibid.* 1873, pp. 469–70; 1874, p. 437; 1875, pp. 204, 620; 1878, pp. 197 sqq.

[2] Bell, *ibid.* 1875, *Report on a Visit to the United States in* 1874, pp. 114–18. There was a good discussion by Whitwell in *J.I.S. Inst.* 1878, pp. 200 sqq.

[3] *Ibid.* p. 202.

influence on technical practice elsewhere. In their early stages their economy was problematical, at least outside the States, and they had no competitive significance. Curiously enough it was in mass-production steelmaking that foreign innovations had most immediate significance in these years.

The early years of Bessemer steel in England saw little change in the plant used in converting. But from the middle 'seventies, with prices falling and the royalty restraints gone, changes came quickly. Their direction was determined from outside. Two different impulses operated: an impulse to mechanical change, from America; and an impulse to more purely metallurgical change, from Europe. The English steelmakers appear in the guise of selectors, not creators.

When the rapid extension of Bessemer plant in the United States occurred, makers concentrated, characteristically, on introducing novel mechanical equipment, designed on the one hand to reduce labour costs, and on the other to reduce general costs by more rapid work and an increase in the output of a unit of plant. Results were impressive by 1874. They even impressed Bell (who was not himself, however, a maker of steel).[1] It was undeniable that by this time a pair of converters in the States produced at least 50 per cent more than a similar pair in the best European works. In the next few years there were continuous improvements: the record output of 1874 (1500 tons a week for two converters) had been more than doubled by 1880, as a result largely of "the strong but pleasant rivalry of the young men who have assumed control of the plants".[2] The most impressive single change was the introduction by A. L. Holley of a system whereby the bottom of the converter, the most vulnerable part, could be removed and rapidly replaced by a duplicate, necessary repairs to it being carried out with no appreciable delay to the steelmaking operations. This

[1] *Ibid.* 1875, pp. 124–7.

[2] The story is told by Captain Jones, of the Edgar Thomson Steelworks, *J.I.S. Inst.* 1881, pp. 132–3, and *passim.* At the start of his own famous works two breaks occurred in the crossheads of the blowing engines, and the ladle-crane cylinder burst, p. 129. It helped to explain, without justifying, scepticism of American advance.

was accompanied (and incessantly followed) by labour-saving mechanisms, by improvements in layout, and by a co-ordination of operations which kept all parts of the plant continuously employed, "a continuous stream of ingots passing...in steady flow from the pit through the furnace to the rolls".[1]

"Manufacturers in England did not attach so much importance to increasing the quantity of steel produced by any particular converter", explained Josiah Smith of Barrow in 1874, with obvious scepticism, "unless they found that by increasing the quantity they secured increased economy."[2] The principle was faultless. By the next year George Snelus at the West Cumberland works was finding by experience that Holley's bottom passed the test.[3] Others followed his lead. Bolckow Vaughan's arranged the converters in their new plant of 1876 "on the American plan"; that is, the converters were placed in a straight line, not in pairs facing each other, and the ingots were cast on the ground-level, and not in a pit below it. The plan, which facilitated movements of the ingots, became ultimately a part of the recognised "best" practice.[4] Brown, Bayley, and Dixon's were advocating an American arrangement of cranes in the converter shop in 1878.[5] Concurrently with this trend of following America, there were purely English innovations in the machinery of the converter shop,[6] but less fundamental, and not improbably partly a result of the American stimulus (though partly, too, a reflection of Continental competition). Despite the adoption of some elements of American practice, English converters were still proportionately as unproductive compared with the American at the end of the 'seventies as in the earlier years, but the degree of real economy in capital and labour cost was certainly much less than converter statistics suggested; and there is no means of judging whether the pace of American change was

[1] Papers by Holley, with discussions, *J.I.S.Inst.* 1874, pp. 348–83; Bell, *ibid.* 1875, p. 125; narrative of Captain Jones as above; and Holley on position about 1880, *ibid.* 1881, p. 414.

[2] *Ibid.* 1874, p. 364.

[3] *Ibid.* 1875, pp. 203–4.

[4] *Ibid.* 1876, pp. 18, 487–8. For a modern estimate of these innovations cp. F. W. Harbord and J. W. Hall, *Metallurgy of Steel* (1st edn.), pp. 51–2.

[5] *J.I.S. Inst.* 1878, p. 107.

[6] E.g. *ibid.* 1881, pp. 146 sqq.

right as well as the direction, or whether a similar pace suited both countries' circumstances.

In the same years as the importance of American novelties became known to the British steelmakers, they were driven to another form of economy by Continental practice; namely, the charging of the converter with pig iron brought hot in its fluid state directly from the blast furnace. Bessemer had thought of the "direct metal" plan, but not worked it; at Sheffield he had no blast furnace. It had become standard practice to remelt cold pig iron in a cupola; pigs of known composition were mixed in order to obtain a uniform charge for the converter, and it was believed by English makers that a single blast furnace would not continuously supply a product uniform enough in quality for steel. Swedish makers had departed from the British cupola practice in the mid-'sixties and adopted the direct working. They had been followed by the French and by Cockerill's at Seraing. In a discussion at the Iron and Steel Institute in 1874 several English steelmakers recognised that the plan had been taken "beyond the experimental stage". Others, among them the heads of the largest works (the Barrow Company), resisted the conclusion. "In fact they had tried some experiments, and arrived at the conclusion that it was a very doubtful undertaking." There was a fatal objection: "it was utterly impossible, when the pig iron was in the furnace, to know what its quality was." The kernel of the problem was indeed skill in blast-furnace management. It was noticed by Whitwell that when the process was used abroad great care was taken in the mixing of the ores for the furnace charge, and the care was rewarded by a very regular result. It is reasonable to assume that Continental makers were in this gaining from advances which Jordan had noted in 1867; but Bolckow's had found it quite possible by 1874 to produce a suitably uniform hematite pig, and planned to follow the Continental lead in their new works. Two years later several works had made the change: even Barrow had been convinced, though it had to carry its molten pig a two miles' transit across the railway. Josiah Smith, the manager, in an unusual humble mood, was ashamed to have been so cautious,

and the chief owner, Schneider, allowed that falling prices had "sharpened the Barrow wits".[1]

America adopted "direct metal" as late as England, but almost at once took the step which finally removed doubts as to the soundness of the process. Holley had introduced an "intermediate ladle" between the cupola and the converters into the Bessemer works which he designed, in order to have a supply of molten metal and thus ensure continuity of work. Snelus, who greatly admired the device, in 1874 pointed out at the Iron and Steel Institute the potential value of this for the "hot metal" process; the "intermediate ladle" could be used to take the iron from two blast furnaces, and any slight irregularity in the composition of the pig iron from a furnace would tend to be corrected by mixing. Snelus was unsuccessful in his efforts to introduce the plan in England, perhaps mainly through the opposition of Edward Williams, who as manager of Bolckow's was responsible for first introducing "direct metal" working into England, and who became an immovable believer in the process undefiled. In the States, however, the plan was taken up at the Bethlehem works in 1878, where Fritz put up a thirty-ton ladle to receive blast-furnace metal, to obtain a good mixture, and hold it in readiness for the converter. It was the first "mixer".[2]

The saving allowed by the elimination of the cupola, which at the West Cumberland works amounted to over 4*s*. on a ton of steel, and which Windsor Richards measured as at least 2*s*. anywhere, was largely a saving of fuel cost.[3] Together with another change the innovation allowed a nearer approach to Bessemer's original claim to make steel without fuel. The other change was the utilising of the surplus blast-furnace gas which was left, in the best works, after the needs of blowing engines

[1] The subject was authoritatively discussed first at the Iron and Steel Institute in 1874, when no English firm was using "direct metal": *J.I.S. Inst.* 1874, pp. 356–66. The quotations are from Windsor Richards (p. 359); Sir James Ramsden and Mr Schneider of Barrow (pp. 356–7); Whitwell (p. 365). In 1876 Josiah Smith opened a second discussion to report progress; and again the leading makers joined in: *ibid.* 1876, pp. 12–42, 420–7.

[2] *Ibid.* 1874, pp. 362; 1878, p. 124.

[3] *Ibid.* 1876, p. 21; 1880, p. 567.

and stoves had been met;[1] the gas was available for steelworks' heat or power supply. "Every Bessemer steelworks (according to Bell in 1878) either did—or ought to be able to—effect the whole of the operation from the manufacture of the pig iron up to the ingot with the quantity of heat obtained in the blast furnace."[2] Probably few works reached Bell's ideal, but the contiguity of steelworks and iron smelting was becoming recognised as a necessary condition of efficiency. In 1882 there were still sixteen Bessemer plants in England without blast furnaces attached; they made, however, only half the tonnage produced by the twelve more integrated plants (which made 954,000 tons).[3] The same tendency was observed in Germany.

While the Bessemer process was improved increasingly for cheap mass production, the alternate, open-hearth, process was advancing slowly. At first its economic value was not clear, since production costs were above Bessemer costs. By 1875, as prices fell and Bessemer work cheapened, Siemens' Landore plant was unable to compete in rail manufacture, which formed its only market.[4] It had been recognised from the outset that the lengthy open-hearth method gave more scope for quality control than the Bessemer process, but neither makers nor buyers had at this date found much in actual results to justify its higher cost.[5] This position was rapidly changed in the mid-'seventies, largely as a result of the work of French metallurgists. It was in France that the most fruitful form of the process, if not the most fundamental, the use of the Siemens' regenerative furnace for melting a mixture of pig iron and steel scrap, had been first made a practical success by Martin in 1867. The next stage of advance was

[1] *Ibid.* 1875, p. 161. [2] *Ibid.* 1878, p. 447.

[3] *Ibid.* 1882, pp. 152 sqq.: in which J. S. Jeans, secretary to the British Iron Trade Association, discusses figures which had been supplied to him. There was still apparently a coal-consumption item in all Bessemer converter shops.

[4] The position is described by James Riley, who in the 'seventies was manager at Landore, *ibid.* 1884, p. 443.

[5] "Siemens has enabled us to produce the same metal (as Bessemer)...by an entirely different process...and with all the excellent qualities of Bessemer metal." Menelaus, as President, *ibid.* 1875, p. 27. The view is representative. Menelaus did not allude to commercial drawbacks to the new process, perhaps because it enabled him to utilise the scrap from his Bessemer plant.

made by the metallurgists of the Terre Noire works, St Etienne—Gautier, Pourcel and Euverte. They were working primarily to produce new high-quality steels of specified characteristics, but it was soon found that the methods of working whose value they demonstrated were achieved with more ease, and probably with more certainty, in the open hearth than in the converter.

The work which first attracted international attention was the production by 1875 of mild steel for ship plates and boiler plates of a quality and regularity far in advance of any produced elsewhere. When French naval constructors were known to be using steel extensively in their ships at this time, Nathaniel Barnaby, the English Director of Naval Construction, visited Lorient to observe and report. "I saw a material", he later said, "which . . . stood the attack of the guns upon it in a manner which surprised the French officers: and I had never seen in England a steel so mild or which seemed to me to be so well fitted for shipbuilding purposes."[1] The makers of this material made no secret of the main features of their process. Success was due to the production and use of ferro-manganese of a new quality. Manganese was normally introduced in the Bessemer and Siemens' processes in the form of spiegeleisen, a compound of iron and manganese where the percentage of manganese varied between 10 and 20. The French ferro-manganese was a similar compound in which the manganese percentage was 75 and over; by its use it was possible to introduce manganese into steel without an appreciable simultaneous addition of carbon, which was unavoidable in using spiegel, and to obtain a metal remarkably malleable either when hot or cold. Ferro-manganese was not originally a French, but a British, invention; and a product with 25 per cent was on the British market in 1867. Although its value had been remarked for the production of ductile plates it had not proved a commercial success;[2] and the Terre Noire works bought up the patent, improved on the process, and made an infinitely richer alloy at a greatly reduced

[1] *Trans. Inst. of Naval Architects*, 1876, p. 149.

[2] A. Hewitt, in *Report of U.S. Commission to the Paris Exhibition*, 1869, II, p. 75, and *J.I.S. Inst.* 1877, p. 137.

cost, using a blast furnace instead of a Siemens' furnace.[1] In addition to exploring successfully the modes of employing this alloy both in the converter and the open hearth, the Terre Noire works (and other French works) put it on the market at relatively cheap rates. Oddly enough, in those years when France was developing the production of "ferro", a large number of English steelworks began making spiegel, which they had hitherto imported.[2]

Barnaby, returned from France, immediately asked English steelmakers whether they could supply steel of the kind he had seen. Most said no; but there were two exceptions—the Bolton Steelworks (a Bessemer plant) and the Landore open-hearth works. Both received naval orders, adopted the French process, and were successful.[3] In a short time other makers, among them the Crewe[4] and West Cumberland works,[5] were also using ferro-manganese and making on a large scale a very mild steel which, in the late 'seventies, came to be known as "the new material". It was very profitable. "Before the introduction...of that new alloy", Gautier rightly claimed, "the steelmakers always said they made good plate with spiegel, but nobody would employ it, or they could not succeed when they did."[6] Within a few years of the introduction of ferro-manganese the new mild steel had an established reputation and Riley was able to speak of an

[1] The position is shown in a paper by Gautier, followed by an interesting discussion, in *J.I.S. Inst.* 1876, pp. 43 sqq. There is a fuller treatment of the history of ferro-manganese making by Åkerman, *ibid.* 1878, pp. 367–8. Terre Noire bought up a German patent as well as an English one at the outset of their work. Cp. also R. Hadfield's retrospective view, *ibid.* 1888, I, pp. 42–4; and Hackney (of Landore) in *Minutes of the Proceedings of the Institute of Civil Engineers*, 1874–5, XLII, p. 40.

[2] *J.I.S. Inst.* 1874, pp. 68–92.

[3] *Transactions of the Institute of Naval Architects*, 1876, pp. 142 sqq. Riley described his steel to the Institute, showing its value by a comparison with "the finest specimens of puddled plate which I believe have yet been made—namely those manufactured at Borsig's Works" (Upper Silesia) (p. 155). Some detail of the adoption of ferro-manganese at Bolton is given by the manager in *J.I.S. Inst.* 1877, pp. 135–6: "All steelmakers owe a great debt to the Terre Noire Company."

[4] *J.I.S. Inst.* 1876, p. 47.

[5] *Ibid.* 1877, p. 89. Snelus speaks of Terre Noire as "pioneers in producing the extremely soft steel from which we are now reaping so much benefit".

[6] *Ibid.* 1876, p. 103. The experience had been universal, not merely English. Perhaps there had been some prejudice. In the case of boiler plates at least it was not a price problem.

"enormous growth in its consumption", in the form of plates and angles for ship, boiler and bridge construction.[1] In private shipbuilding, for instance, "the real start (in the use of steel) was made in 1878". By the turn of the decade the material was being used instead of charcoal iron for the making of best-quality tin plate.[2]

It is noticeable that although the "new material" was made both by the converter process and the open hearth, the Siemens' steelmakers found they could now compete with the Bessemer firms who, by 1875, were beating them in railmaking. The Landore works was saved from "a lingering, miserable existence" when it could turn to special steels.[3] The explanation of this is not remote. Snelus, virtually defending his own Bessemer plant, agreed in 1877 that "there might be a little more trouble" in applying the Terre Noire process to the Bessemer than to the Siemens' process.[4] The discussions of the later 'seventies show clearly that many users of steel thought that there was a lack of regularity in the Bessemer product, even when the "little more trouble" had been taken.[5] It is probable that this was so, particularly since in the open hearth "the exercise of the most minute attention" was said to be essential.[6] But whether this was really so or not, it is clear that in the late 'seventies many persons would use Siemens' steel who suspected Bessemer products. At the same time the production costs in Bessemer works were necessarily far higher for high-grade mild steel than in rail manufacture: expenses in the two processes were more nearly level.[7] Thus when Siemens "looked upon the steel which had latterly been brought forward so much by the Terre Noire Company as a feather in the cap of the open-hearth process",[8] he was presumably finding confirmation in the pocket.

[1] *J.I.S. Inst.* 1884, p. 443.
[2] *Ibid. loc. cit.* and 1879, p. 45.
[3] *Ibid.* 1884, p. 443.
[4] *Ibid.* 1877, p. 91
[5] E.g. Adamson, *ibid.* 1878, pp. 396–7; Barnaby, *ibid.* 1879, pp. 45 sqq. The view was not held universally.
[6] Pourcel, *ibid.* 1879, p. 387. Pourcel said it was difficult to get good results with the pig and ore process, and noted that English makers were using scrap increasingly as well as ore. English makers explained this on economic grounds—there was scrap to be used and it was cheap.
[7] E.g. Snelus, *ibid.* 1879, p. 407, and again, 1889, I, p. 165.
[8] *Ibid.* 1878, p. 458.

Within a few years of the launching of "the new material" the Terre Noire metallurgists were again earning the applause of steelmakers, this time for advancing the manufacture of steel castings. The materials which they employed, silicon and manganese, had long been used by the pioneers of steel casting; among whom the Bochum works had been the first. Silicon obviated the "honeycombing" of the steel with "blow holes"; but makers found that silicon steels were brittle. The Terre Noire product was tougher than the earlier castings had usually been; a result achieved partly by the mode of making the steel, and partly by a process of careful reheating and cooling, which broke down the coarse crystalline structure.[1] "The behaviour of manganese and silicon as well as their proportion in the process of steelmaking", according to Holley, "was brought by a long course of expensive experiments from the region of speculative guesswork to that of exact science"; and he prophesied that the work would open up "a very large and important department of the open-hearth manufacture".[2] English and Swedish experts, some of them makers, and some of them users of steel, confirmed Holley's verdict. Those who took part in the English discussion, with one exception, were agreed that a new level of achievement had been reached which showed that "much more was to be done in castings" than hitherto.[3] The exception was Robert Hadfield, speaking of crucible steel castings; but, however high the quality of his castings may have been, the potential economic scope of his process, because of costs, was far less than that of the French.[4] Barnaby was impressed by the possible application in the making of ships and their engines of the new French process for producing steel castings as he had been impressed by the scope of French mild steel a few years since.[5] "A great manufacturing country", he told the steelmakers, "should be reluctant to lose the lead in

[1] Paper by Gautier, followed by discussion, *J.I.S. Inst.* 1877, pp. 40 sqq., and Åkerman, *ibid.* 1874, pp. 380–1.

[2] *Ibid.* 1877, pp. 86–8.

[3] *Ibid.* 1877, pp. 85–103, 401–3; views of Snelus, Adamson, Sharp (of Bolton) and Siemens. Also 1878, pp. 380–1; 1879, p. 526 (Åkerman).

[4] *Ibid.* 1877, p. 92. Hadfield has given credit fully to these developments on later occasions.

[5] E.g. *ibid.* 1879, pp. 53–4.

improvement in materials and modes of manufacture, and we have certainly been very near to losing it in the right application of great English inventions to the wants of shipbuilding and marine engineering."[1]

Beyond the ingot-producing stage the activity of English steelmakers in altering their plants ceased to have the eclectic, uncreative character which was exemplified in the melting shops. Some of the most fundamental innovations of these years in the mechanical processes immediately following the casting of the ingots had their origin in England.

Steel rolling about 1870 was almost wholly rail rolling. In two ways, at this time, the more progressive English makers were beginning to break away from traditional methods. The first break was to substitute "cogging" by rollers for "cogging" by steam hammers. It had been at first thought essential to consolidate the structure of an ingot by hammering, prior to rolling it into its sectional form. By 1867 Abram Hewitt, the American official representative at the Paris Exhibition, discovered with approval that several of the bigger of the English works, including Crewe and Dowlais, had replaced the hammers by rolls.[2] There were opponents who supposed there was a loss of quality, but the thing advanced. Brown, Bayley, and Dixon's introduced it into Sheffield, and John Brown's were driven to it by falling prices in 1874. Here, eighteen men and one mill did the work of three hammers and fifty-four men.[3] The plan was adopted in the 'seventies outside England very generally. The second break in rail-rolling practice was the introduction of reversing mills. In England, until 1866, the heated metal was put through a pair of rolls in one direction only; it was then handed back over the top of the rolls to its original position, to enter them for the second "pass". In that year Ramsbottom at Crewe determined to apply a reversing engine to the driving of the rolls, so that unusually heavy iron plates, which had passed through the rolls in one direction, could pass back through the

[1] *J.I.S. Inst.* 1879, pp. 46, 54.
[2] Hewitt, *op. cit.* p. 69.
[3] *I.C.T.R.* 1874, p. 760.

rolls in the reverse direction, since otherwise the handling problem was severe. When it had been shown to be mechanically possible—it threw great strain on a steam engine to be reversed every few seconds—the principle was applied to steel-rail production. Dowlais, again, was among the pioneers. There was a considerable reduction in the manipulation of the metal being rolled, and with it a great saving of time. The mill capacity was more than doubled. But there was a drawback as well, since, partly because of the severe strain and partly because the reversing engine could make no use of its momentum, it was necessary to employ more powerful engines than heretofore.

In the United States the problem which English railmakers solved by the reversing mill had been solved in another way—by the use of "three-high" rolling mills. In these a third roller was placed above the top roller of the first pair, and when the metal had passed through the lower rolls it was lifted up and returned between the upper two rolls. The rolls did not need to reverse, the steam engine had the advantage of momentum in meeting the intermittent load, and the work could be carried on more rapidly than in the reversing mill (since the time occupied in the process of reversing was saved).[1] Mills of this type were invented by Fritz at Pittsburg in 1857; they had been invented and in use on the Continent in the preceding decade, though not in the first place for rails.[2] In the Bessemer plants erected in the 'seventies the Americans employed them both for cogging and finishing; by this time the mechanism had gone through a long process of improvement, and Bell spoke of one plant as "a masterpiece of machinery for strength and accuracy".[3]

English discussions in the early 'seventies on steel-rail making in three-high and reversing mills were illuminating. No certain judgment can be formed from them with regard to the comparison of the mechanical economies of the two types of mill when at work: though it is likely that the three-high mill gained more by greater speed and the more efficient use of steam than

[1] There is a good early discussion in *J.I.S. Inst.* 1872, II, pp. 87 sqq.
[2] Hewitt, *op. cit.* p. 24, says these mills were used at Anzin for girders in 1849.
[3] *J.I.S. Inst.* 1875, p. 127.

it lost by the more burdensome manipulation which it involved (since the material had to be lifted or lowered between each pass). The interest of the discussions does not, however, lie mainly in these points, but in a more fundamental problem of mill design—the relation of the type of plant to the market conditions which it has to serve.[1] It was claimed that the three-high rail mill was not adapted to English conditions, where orders were mostly small, sections were innumerable, the prospect of having two successive orders for the same section was slight, and the opportunity for producing for stock nil. Such conditions necessitated a large stock of rolls, which were expensive, and frequent roll changes. Three-high mills would mean still more rolls, and the changing, already serious since the mill was kept inoperative for some hours, would be longer and more costly still. In the States the sections were fewer, orders were bigger.[2] Probably this reflected concessions made by buyers in order to have low prices (Americans notoriously bought the worst and cheapest Welsh iron)[3] or to secure prompt delivery at times of rapidly expanding demand. Makers were able to bully their clients. Admittedly they could and did sell rails of less accurate section than was acceptable in England, and could reduce expense by "redressing" their rolls less frequently.[4] Menelaus, who stressed the unsuitability of the American system for England, had been checked in some interesting developments of iron-rail rolling by the character of English orders; had in fact designed more progressive mass-production mills for French makers than he could use himself, since even they had bigger individual orders.[5] Bessemer was unquestionably reflecting the views of the English industry when in his presidential

[1] The best discussion of the technical comparison of the mills is by W. Hackney, of Landore, in *Minutes of Proc. of Inst. of Civil Engineers*, 1874–5, XLII, pp. 41–4.

[2] Discussion in *J.I.S. Inst.* 1872, pp. 90–3 (Menelaus, Williams, and Snelus); and pp. 353–8 (Holley).

[3] A. Hewitt, *op. cit.* p. 13: "The worst and cheapest Welsh iron is called 'American Rail'."

[4] *J.I.S. Inst.* 1872, *loc. cit.* Americans were in agreement with English critics in this matter.

[5] Menelaus was moving in the direction of a continuous mill for railmaking: *ibid.* 1869, pp. 187–94, and below, p. 193.

address to the Iron and Steel Institute in 1871 he advocated the adoption of Whitworth's standardising principle in railmaking. "The work which a rail has to perform is so perfectly simple and so clearly defined that there cannot at present be any difficulty in establishing a standard rail suitable for all purposes." But as the leading trade journal, wholly favourable to him, commented: "The fancies of engineers are very capricious, and it is easy to see that such a radical change will not be adopted without a great deal of discussion."[1] And certanly not when makers were falling over each other to get orders, as they soon would be.

Alongside the application of the three-high principle to railmaking the United States' makers evolved elaborate labour-saving manipulative mechanism for the movement of the hot metal at the mills. Hewitt in 1867 had noticed the prominence of English makers in this matter;[2] and, at least in Wales, "live rollers" for moving ingots, etc., were employed.[3] By the early 'seventies America had taken the lead. Bell described the plant at the Bethlehem Mill in 1875. Hydraulic cranes moved the ingots in and out of the reheating furnaces, putting them on the feeding tables of the cogging mill. These tables were virtually live roller sets (one on each side of the rolls) which, after delivering the ingot between a pair of rolls, could be raised or lowered as need be, to receive the ingot on the return pass. Between the live rollers, bars which were operated mechanically were raised to move and turn the ingot, like metal fingers. And so to more reheating furnaces, and to the finishing mill. Here there was something to learn, "some superiority of arrangement and some improvement in machinery", said Bell.[4] Though a plant of this kind, like the three-high principle itself, might seem more adjusted to the continuous uniform production of the States, and though it would be the more valuable where labour was dear, the principle soon made headway in England. Bolckow Vaughan's planned for their Eston works a two-high

[1] *I.C.T.R.* March 29, 1871, p. 204.
[2] A. Hewitt, *op. cit.* p. 24.
[3] *J.I.S. Inst.* 1898, I, p. 320–1: obituary of Lewis Richards.
[4] *J.I.S. Inst.* 1875, pp. 126–7.

reversing cogging mill where all the manipulation was hydraulic, and they came at least very near to the American record output of the time.[1]

Though the three-high rail mill had been declared unsuitable in English conditions, it was nevertheless introduced at several important works.[2] As a result of the speed which they attained by this step the Sheffield works of Brown, Bayley, and Dixon's was able to bring another advance into British practice—the elimination of the reheating process between cogging and finishing.[3]

It is not unlikely that the Sheffield firm was anticipated in this step by Cockerill's of Seraing, who adopted the plan successfully in 1875, using a reversing mill.[4] Belgium deserved the priority, since "rolling in one heat" had become a characteristic practice in Belgian malleable ironworks.[5] It was one of several changes in mill plant which in the late 'seventies were suggested as an explanation of the growth of Belgian exports. The elimination of reheating was ultimately bound up with the very general adoption of the three-high mills in ironworks in place of the old pull-over mills, a change which had been pre on English makers by foreign patentees throughout the i s, but which made little headway.[6] According to Windsor ds the newer mills not merely saved labour and fuel but enabled makers to roll difficult sections of channel iron, angle iron and T iron".[7] Besides departing from British practice by using three-high mills the Belgians adopted extensively the

1 *J.I.S. Inst.* 1876, pp. 487–8; 1881, pp. 311–12: there was some dispute about capacities; apparently Bolckow's in 1880 had a heavier output, but they made a heavier section rail; the speed of work was probably less.

2 Barrow was using three-high mills in 1875: *Minutes of Proc. of Inst. of Civil Engineers*, 1874–5, XLII, pp. 86–8; Crewe, the home of Ramsbottom's reversing engine, introduced a three-high mill in 1876, using a Corliss engine: *J.I.S. Inst.* 1876, p. 483. Steel, Tozer and Hampton's used these mills for cogging in a new plant in 1878: *ibid.* 1879, p. 564.

3 *J.I.S. Inst.* 1878, p. 113.

4 *Ibid.* 1875, p. 201.

5 A valuable summary by a distinguished Belgian metallurgist (M. Deby) of the improvements in Belgian ironworks practice is given, *ibid.* 1877, II, p. 149.

6 *Ibid.* 1872, pp. 86 sqq.

7 *Ibid.* 1878, p. 279. Address as President to the Cleveland Iron Trade Foremen's Association. The gist of the address was that the Continental engineers were working hard while the English rested on their oars.

"Universal" mill, in which a pair of vertical rolls is used in addition to the horizontal rolls, and four sides of a bar or sheet or plate may be rolled at once without the use of grooved rolls. This form of mill had been praised by Bell in 1867, and by the Staffordshire ironmaster, Walter Williams.[1] The economies are clear: a saving in rolls, and, in the case of sheets and plates, avoidance of the work of shearing and of the waste represented by the scrap metal sheared off. The mill was suited to small orders. But it was difficult to adjust. English makers, who did not welcome it,[2] said it made poor-quality stuff: stuff which nevertheless sold. Windsor Richards emphasised other changes in equipment apart from the adoption of better mills. In the works he visited "they had thrown out all the old boilers, and adopted those of the best type...they had also thrown out the old engines and adopted the high pressure expanding condensing engines of the best type...gas heating furnaces had taken the place of the old-fashioned furnace, which was so well known to be wasteful of iron and coal and constantly requiring repairs". Clearly he thought these improvements more widely spread than in British ironworks.[3] Among the heating furnaces, he discovered at Seraing what to him was a novelty, a furnace "thirty feet long", where "the ingots were placed in one end, the furthest from the fire, and rolled on to the other end, and by the time they had reached it they were sufficiently heated to be taken out one by one and rolled". This was an ancestor of the "continuous" reheating furnace, but not the original. The home of the innovation was at Bochum, and several German plants

[1] I. L. Bell, in *Ann. Rep. Brit. Assoc.* 1867, p. 36, and Creed and Williams, *Handicraftsmen and Capitalists*, p. 63. Both sources point out that though not used in England this type of mill was the invention of Mr Arrowsmith of Bilston.

[2] The first English Universal Mill was erected in Darlington in 1878. *J.I.S. Inst.* 1878, p. 540. It "rolls the plates as clean as ribands and as straight as dies".

[3] A similar view was forcibly expressed by a group of members of the South Staffordshire and East Worcestershire Institute of Mining Engineers who visited Belgium in 1870. Belgian advance in the iron industry was attributed to "bold engineering enterprises, yet rigid economy". "More care and skill are shown in laying out their ironworks than in most parts of Britain." All this was to be attributed to the enterprise of owners, not to the quality of technicians. Some English districts were making up, and "a revolution is being wrought". Report, quoted from *The Times* in *I.C.T.R.* July 6, 1870, p. 437.

had adopted the plan.[1] It was not the only feature of Belgian practice impressive to English observers which to a considerable degree distinguished German and also French practice; in both countries variety of mill types, for example, was far greater than in England.

It was in the processes of smelting, ingot production, and rolling that the major technical changes in the iron and steel industries occurred in these years; in puddling, forging, etc., modifications were either less fruitful or less far-reaching. Their history does not disturb the balance of the picture of international activity which emerges from the more significant developments hitherto traced. Puddling had an eventful history, but mechanisation was not satisfactorily achieved. Danks, whose new furnace was the most discussed, was an American; but all the leading ironmaking countries had important experimenters, and there is little distinction between their achievements—certainly no question of English primacy.[2] In the application of steel to the purposes of war Germany and France continued to be more adventurous than Britain, Krupp making the first all-steel guns, while Creusot pioneered with steel armour plate.[3] It was in connexion with this aspect of steelmaking that Whitworth developed in the late 'sixties the process of compressing liquid steel by hydraulic power in order to obtain sounder ingots. It was the most famous contemporary application of the hydraulic press in the steel industry, but its practical significance was small, and the problem which Whitworth tried to solve mechanically was already receiving in Europe some of the chemical solutions which made the use of pressure superfluous or at least

[1] *J.I.S. Inst.* 1880, II, p. 61.

[2] The subject was very frequently discussed at the Iron and Steel Institute in the 'seventies. Steps which economised labour and fuel without constituting a wholly mechanical process appear to have made more headway in Europe than in England. Cp. Siemens, and Farnworth (of Baldwin's) in discussion, *J.I.S. Inst.* 1876, pp. 134, 136. Also *ibid.* 1877, pp. 223–4.

[3] Cp. Menelaus, *J.I.S. Inst.* 1875, pp. 30–2, and 1881, II, pp. 424 sqq.; *Proceedings of the Institute of Mechanical Engineers*, 1879, pp. 60 sqq. Since experimenting with armour plate and large guns is expensive the slow English development may have been, as makers complained, mainly due to the Government policy.

uneconomic in the production of ingots.[1] A more significant development was the use of the hydraulic press for "die forging", the forcing of hot (but not molten) iron or steel into metal moulds, in order to manufacture railway wheels, cranks, and the like quickly, which otherwise provided elaborate jobs for smiths. This special type of press was devised by an Englishman (Haswell), but applied in Germany and Austria; the reason, according to English locomotive makers, being that in England locomotive standardisation was not sufficient to give the press the working condition necessary for its success—namely, the possibility of repetition.[2] Apart from this type of press, hydraulic forging made no appreciable headway at this time: the idea was familiar, the value of pressing rather than hammering was appreciated, and Bessemer had made the process the subject of one of his numberless patents. But expense was against it.

When Bell discussed the menace of foreign technical accomplishment in 1867, at the time of the first serious misgivings, he allowed importance only to forms of Continental advance which he alleged had a commercial value in Europe when they had none here; for certain minor advances (such as the development of the universal mill) where this condition did not apply he was content to claim for England (sometimes with doubtful accuracy) priority in the fundamental idea or in the first tentative efforts. In the following decade, when the predominance of foreign advance in many branches of the industry was indisputable, it

[1] The subject is too complex to allow of a full discussion here. Early discussions of Whitworth's process occur in the *Proc. Inst. Mech. Eng.* 1875, pp. 271 sqq. and *ibid.* 1880, pp. 400, 409. Barrow and Bolckow's were trying a cheaper American process at this time, and Snelus was urging the claims of a chemical solution of the problem. Sheffield did not take up compressing till about 1905, and then under pressure from the Government. Moreover it was a French process (Harmet's), not Whitworth's, which was adopted. Very interesting discussions occurred in 1902–4: *J.I.S. Inst.* 1902, II, pp. 146 sqq. and 1904, I, pp. 63 sqq. Also Harbord and Hall, *op. cit.* II, p. 453. The Sheffield firms were not satisfied with compression, and gave it up: its history in Sheffield is discussed by Dr Hatfield in *J.I.S. Inst.* 1930, II, p. 29. The Skoda works was still persisting with compression.

[2] *Ibid.* 1876, pp. 428 sqq. The discussion was very illuminating. Mr Walker, of Tannett Walker's, said: "The great difficulty in this country is that many of the railways made their own engines, and all had notions of their own." Kitson, though critical of Haswell's process, "would welcome any move towards a system of duplication".

was not possible to maintain the first proposition with all its implications. The proportion of foreign advances which proved at this time unsuited to English conditions—of demand, of labour, or of raw materials—was not imposing. Rapid adaptation in the later 'seventies indicated the real position. On the other hand—a dubious consolation—it was still true that many of the ideas on which advances were built had originated in England; and, still more, had for a long time been current. The ideas of using "direct metal", of the mixer, of ferro-maganese, of duplicate converter bottoms, were probably of English origin, and had either been discussed or experimented with in England, but they had gained no foothold. And the ideas of the three-high and of the universal mill had been current in England at least since 1860. The position in England was indeed characterised not by a lack of ideas, but by some degree of failure on the part of the English iron and steelmakers either in the appreciation of or welcome given to novel principles, or in the mode of their development and application.

This cannot be accounted for by a lack of opportunity; for the period was one during which big additions were made to the plant in most branches of the industry, and there was no lack of capital, as the improvement of steel equipment in the depression years abundantly proves. A seductive contemporary suggestion explained the position by the demoralising profitability of Bessemer steelmaking in its early days, which caused a neglect of possible new economies. Menelaus of Dowlais and Schneider of Barrow pleaded profits in this way.[1] The argument was double-edged; for, since makers fully recognised in the late 'sixties that the steel-rail market could be greatly extended if prices were lower,[2] it implied a lack of commercial and technical energy. Possibly their argument had some substance, but it is not a complete explanation, and it is noticeable that nothing in the activity stimulated by the "desperate pinch" of 1875–9 shows a change of trend; most of the novelties now adopted in England had been proved elsewhere. It is indeed likely that the

[1] Above, p. 50; *J.I.S. Inst.* 1876, p. 41.

[2] Cf. e.g. a discussion of the Iron and Steel Institute reported in *Engineering*, 1869, II, p. 224.

disinclination to make radical changes should not be explained mainly by forces of a temporary or incidental nature.

The critics of 1867 had scented danger in an attachment to routine and a lack of adequate training. The events of the next decade were compatible with this, and may indicate no change in the habits of the English industry. A few prominent features in the history of the industry since 1850, particularly the introduction of the new steelmaking processes, give the impression that the ironmasters were straining after improvements. The impression is rather misleading. Neither Bessemer nor Siemens was warmly welcomed, and both found difficulty in getting their inventions tried. Only Cleveland in these years did much for blast-furnace advance; some of its leaders thought that they were approaching finality by 1870. Edward Williams, who hailed from Dowlais and managed Bolckow Vaughan's for some time, was trying at that date to account for "the fact that ironmaking has not improved at the same rate of progress as other industries in the last forty years".[1] Puddling, he asserted, had undergone no radical change after Baldwyn Rogers (about 1820) suggested replacing the sand bottom of the furnace by cast iron; an innovation which earned him "no reward save local celebrity and a nickname", but after a period of ridicule and some modification became a normal practice.[2] Rolling practice, he claimed on a later occasion, had remained unchanged for forty years (it was Williams's standard period) apart from increases in the strength of engines and the weight of rolls.[3] Windsor Richards, who came from Ebbw Vale to succeed Williams at the Cleveland works, thought in 1878 that the English manufacturers and engineers had been recently "resting somewhat on their oars".[4] There is much to suggest that many had rested, or at least been stationary, quite a long time. In this perspective the lagging of England in technical matters is not so strange.

[1] In the Opening Address of the Cleveland Iron Trade Foremen's Association: reported in *I.C.T.R.* 1870.

[2] *Ibid. loc. cit.*; also Williams's presidential address in *J.I.S. Inst.* 1879, p. 20.

[3] *Ibid.* 1878, p. 124.

[4] Address to Cleveland Iron Trade Foremen's Association, *ibid.* 1878, p. 279.

To Windsor Richards "resting on their oars" was a sounder and alternative explanation of slowness than a decline of skill. Possibly he was narrowly right in sensing no positive decline; but his view was not comprehensive. Distaste for the effort and expense of making changes no doubt there was. But there was also a lot of tentative unsuccessful effort in England at changes which were brought to fruition elsewhere, as the discussions of the time often revealed. They suggest that there was a lack of appropriate skill. There were contemporaries who recognised this, and it was expressed admirably by Siemens in a presidential address to the Iron and Steel Institute when it met at Paris on the occasion of the Third International Exhibition. (The exhibitions were eleventh-yearly functions there from 1856.) "England", he said, "must for a long time retain the first position for massive and cheap production (of steel)"—he was thinking of that superior command of resources which more than compensated for dearer labour—"whereas we shall probably find that our neighbours excel in the aptitude they evidently possess for adapting new materials to particular purposes." He proceeded to contrast the French and English mode of attempting advances. "The English, to realise a novel proposition, make bold attempts (not always carefully matured beforehand): the French systematically study a question in all its aspects, and fortify their views by careful inquiry into the experience obtained elsewhere, before they commence operations, which are then carried out with all the economical and other advantages resulting from such an exhaustive preliminary inquiry. If we seek a *cause* for the remarkable aptitude of adapting means to special ends, to which I have referred, we shall probably find it in the advantages France and other Continental countries have enjoyed for at least a generation, of a more extended technical education than we can boast of, and of a personal influence which has been exercised by a line of scientific writers and experimentalists".[1] Which provoked Bell to a defence of those untrained heroes, the Corts, the Neilsons and the Darbys.[2]

[1] *J.I.S. Inst.* 1878, p. 309. [2] *Ibid.* p. 315.

Siemens adopted an analysis and explanation of English deficiencies closely parallel to those propounded by Jordan and Kitson ten years earlier;[1] and there is no reason to lay much emphasis on the implied (but probably not seriously considered) restriction of the explanation to problems bound up with the production of "special" steels. The greater sureness and economy of method which scientific training gave was available for advances in "massive production" as well as for advances in quality production. And the scientists' measurements of potential economy in the use of materials were a stimulus to the type of technical improvements whose value was greatest for plants making a large output of cheap goods.

Though there were comments of 1878 very like those of 1867, and no doubt cogent, it would be erroneous to suppose that the extent and standard of scientific training had remained quite unchanged between those years. But the gap between English and Continental conditions still remained large enough for its influence to be rated high: possibly it had narrowed little as regards the amount of training, though rather more as regards the respect paid to science. In 1882, on the occasion of one of those inquiries into technical education which have so often formed a refrain to periods of industrial depression, Siemens himself remarked on some of the differences. He still thought that the English employer was "more a commercial man, and takes less interest in the technical part of the work" than in France or Germany, and that there was "more prejudice against innovations". But "a taste for science had been awakened among employers.... Twenty years ago I certainly found the greatest possible difficulty in getting ironmasters to look at a new idea, but since that time the Iron and Steel Institute has been founded, and men who formerly ridiculed the idea of chemical analysis now speak of fractional percentages of phosphorus and sulphur with great respect."[2] Bell, in evidence before the same Royal Commission, illustrated the position in the industry with more fullness, tracing a similar but less

[1] Above, pp. 5–6, 11.

[2] *R.C. on Technical Instruction*, 1884, XXXI, Qs. 1488–9.

marked trend. "You would find", he said, "as many employers without scientific knowledge as with it; in the majority of works you would still find there was no person on the managing staff with a scientific training." (He did not add, what Williams was inclined to emphasise, that the Joint-Stock Company meant sometimes a backward movement, replacing the practical man in the "higher management" by men who had neither appropriate experience nor appropriate education.) It happened increasingly, but not yet universally, that properly educated chemists were being appointed at British ironworks. In Middlesbrough there was an unusually large number of blast-furnace managers with the right training; to this fact Bell partly attributed the local success in grappling with blast-furnace problems, but he could not discover any successes to the credit of the well-trained managers of the Continent. Middlesbrough malleable ironworks were still all managed by "good practical men only". So, for that matter, was the Eston steelworks; both Williams and Windsor Richards were in this category. But Bell registered a change in progress; the need for a scientific education was so well recognised now that a young man without it "in a few years will have difficulty in obtaining employment". Employers' recognition of the value of suitable training was not, however, so far developed that government or municipal initiative could be dispensed with in setting up the necessary schools.[1]

The education of workmen and foremen seemed important to Bell only in so far as it made them (particularly the foremen) ready to "listen to the representations of a scientifically educated manager".[2] He sometimes thought the French and German workmen for this reason more willing to accept novelties. "But it might, after all", he added, "arise from the idiosyncrasies of different nations."[3] Whether the "idiosyncrasies of different nations" should be given a more dignified position (and a less euphemistic description) among the influences which moulded the attitudes of employers and managers towards technical change, did not enter into the public speculations of Bell or of

[1] *R.C. on Technical Instruction*, 1884, XXXI, Qs. 235, 236, 238, 240, 271, 287, 290.
[2] *Ibid.* Q. 248.
[3] *Ibid.* Q. 256.

those ironmasters more conscious of English deficiencies. It was inevitably so. They were looking for temporary and remediable forces, or forces which transferred responsibility. In the complacency and somnolence bred by success, in the limitations imposed by unreceptive and individualist markets, in the obstruction of workmen and the numbing influence of inadequate education, there appeared sufficient explanation of failings which had little immediate commercial significance. Those persons who touched on the more fundamental problem, in the form most appreciated at the time, wondering whether England was able to succeed in an increasingly scientific industry as she had succeeded in the days of rule of thumb, gathered confidence from the fact that in the past England had never lacked scientists of the greatest distinction; she had only lacked scientists of the rank and file.[1]

[1] *R.C. on Technical Instruction*, 1884, XXXI, Q. 3055 (Evidence of T. H. Huxley); also *Quarterly Review*, Oct. 1867, pp. 486–7.

BOOK II

EARLY EDWARDIAN CLIMAX

cent in three years. When maximum production and export had been reached in England prices were, however, deemed unsatisfactory; and as early as the autumn of 1881 blast-furnace owners were jointly restricting the output of some qualities,[1] to be followed in the next year by the steel-rail makers, who "met with a view to maintaining prices".[2]

During this period, when attention was diverted from foreign competition, the bases of this competition were in two ways greatly strengthened. In the first place (and of least importance), German industry emerged from the ordeal of the 'seventies with new defensive duties, whose shelter allowed it to raid export markets with goods sold at considerably less than the home price.[3] The second change was far more fundamental, for its influence depended on physical, not on political, conditions, and its importance extended beyond the confines of a single State. This change was the introduction, by an English inventor, of the Basic Process.

Sydney Gilchrist Thomas had announced his famous discovery of how to eliminate phosphorus from steel in the Bessemer process, during the discussion at the Iron and Steel Institute of a paper in which Bell described his work on the phosphorus problem.[4] Bell received Thomas's announcement with patronising scepticism. At the next meeting of the Institute, the Paris meeting at which Siemens generalised on the strength of England's position for the "massive and cheap production" of steel, Thomas had a paper on the agenda: but the order went round, priority to foreign papers—and there was no time for the basic process. Windsor Richards, however, was farsighted enough to give the new plan a trial at Middlesbrough on a scale hitherto denied it, and when ultimately in 1879 the process was described to the Institute, technical success seemed to most hearers to be within reach.[5]

Like the two other great recent English steel inventions, dephosphorising was not discovered within the steel industry.

[1] *Econ.* Nov. 17, 1881.

[2] *Econ. Commer. Hist.* for 1882, p. 31.

[3] Kestner, *op. cit.* ch. I.

[4] *J.I.S. Inst.* 1878, pp. 40, 46.

[5] Paper and discussion in *J.I.S. Inst.* 1879.

"An amateur[1] pressed it upon the ironmakers", as Edward Williams had it, "and it was not to the credit of the ironmakers" that it should have been so. (It was not, of course, specially derogatory to the English.) Thomas's fundamental idea[2] had occurred to several chemists in the steel industry. It was that the phosphorus in pig iron, which was found in the converter in the form of phosphoric acid, should be brought into contact with some cheap basic material (such as limestone) with which it would combine to form a slag easily separable from the steel. The difficulty was that at the high temperatures reached in the converter there were reactions between the converter lining and the charge of molten iron. The linings in use at that time contained a large proportion of silica, which was an acid with stronger affinities than phosphoric acid for basic material. Hence to charge basic additions with the pig iron would destroy the normal converter lining instead of removing phosphorus. Several distinguished metallurgists had attempted to solve the problem by using a cheap basic lining instead of the acid—silica—lining,[3] intending that the reaction of the lining and the charge should remove the phosphorus. None had discovered a tolerably durable lining. Thomas made important steps towards the solution of this aspect of the problem. But the more original part of his process was the employment for dephosphorising both of a basic lining and of additions of basic materials—mainly limestone—to the converter charge. This was important in two ways. In the first place, it ensured a more regular contact of the basic material and the phosphorus than would have occurred had dephosphorising depended solely on the lining. In the second place the use of the converter lining as a subsidiary dephosphorising agent only would lengthen the life of the lining, although even in Thomas's process it was clear that

[1] It need not be added, not an amateur as a scientist.

[2] Described in Thomas's paper of 1879.

[3] Siemens and Le Chatelier had worked on this in 1863; Snelus took a patent for a limestone lining in 1872 (*J.I.S. Inst.* 1878, p. 35). The patent rights for the basic process (as Snelus named it: "the anonymous process", said Thomas) were shared in England by Thomas, Snelus and Riley. Thomas was sole holder of the patents outside England.

relining must be more frequent than in the established "acid" process.

The new process must be dearer than the old. Basic additions were a new expense; there would be more slag; relining would be more onerous, and working more interrupted. How far would the cheapness of the pig iron now made available for steel compensate for the additional costs of manufacture? Here England's Continental competitors gained. Germany and Belgium could both produce a suitable phosphoric pig iron from the minette ores at least as cheaply as England, and the margin between the costs of hematite and of phosphoric pig was for them far greater than for England.[1] In the circumstances it does not surprise that Continental steelmakers were more quickly convinced of the commercial prospects of the process than their English fellows. They feverishly bought licences to work the process,[2] and the German steelmakers soon became leaders both in the technical perfection and commercial application of the discovery.[3] Within a remarkably short time they had shown that Thomas steel could be made cheaply and could be used in place of Bessemer (acid) steel for most purposes. For some purposes it was actually the more suitable material. The basic process proved almost immediately to be peculiarly adapted to the making of steel of exceptional ductility, very low in carbon, which was admirable for such purposes as wire drawing.[4]

Once the technical success of the process was achieved the competitive situation in the steel industry was revolutionised. In England in the 'eighties the discovery probably did not allow

[1] These problems of cost are discussed below in ch. VIII.

[2] There is a legend that Thomas sold rights for a mere song and a good dinner. (A. Sömme, *La Lorraine Métallurgique*, Paris, 1930, p. 10.) A law case in 1892 over the patents showed that the English holders of the foreign patents had earned at least £138,000 from them, *Engineering*, Feb. 26, 1892. Thomas was careful to protect his patents. The proceeds he "bequeathed to the relief of distress among the working classes."

[3] Cp. letter of Sydney Thomas to *The Times*, quoted in *J.I.S. Inst.* 1880, p. 672. He commends the "intelligence and well directed energy" of the Continental ironmasters "who have already gained a lead over their English rivals which it will not be easy for the latter to recover".

[4] Articles in *J.I.S. Inst.* 1880, pp. 55, 80, 475.

a very great cheapening of the costs of steelmaking. But in the minette regions of Europe it did; and there was now nothing in the raw material situation to prevent Continental makers in some important districts from producing steel at costs closely parallel to English costs. The fundamental basis of close competition between England, Germany and Belgium was thus extended to the whole of the manufactured iron and steel industry. Thomas had "dealt a blow"—a fatal blow—"at the supremacy of English hematite steel".[1]

The significance of the two changes of 1879—the new tariff and the new process—was appreciated in England in the middle of the 'eighties. By this time the industry was again plunged in distress. Exports, following the traditional switchback course, dropped rapidly between 1882 and 1885; a lull in shipbuilding[2] cut down the home consumption seriously at the same time, and prices fell to a lower level than had hitherto been experienced. Cleveland pig iron, for instance, whose lowest price in the early part of 1879 was 32*s.* 6*d.*,[3] averaged 30*s.* 4*d.* in the last quarter of 1886.[4]

The decline in exports was not to be explained mainly by the growth in the exporting power of other countries. It was due in part to a further growth in the producing capacity of the American home industry, but the more important influence was the falling off in world demand for iron and steel. This falling off, in its turn, was to be explained by two factors, whose operation could not in practice be wholly distinguished. In the first place, the railway extensions, which had been the main cause of the export boom, carried enough goods to market from newly opened country to depress produce prices, but did not obtain enough business to become quickly profitable lines.[5] This was the major factor; the minor factor was the continued

[1] *Econ. Supplement*, Jan. 9, 1886, p. 5.

[2] Between 1879 and 1883 shipping capacity had been increased by 40 per cent: *Econ.* Nov. 8, 1884, p. 1353.

[3] *Econ.* Sept. 3, 1879, p. 1049.

[4] Price ascertained for sliding scale wage adjustments.

[5] *Econ. Commer. Hist.* for 1884, p. 7, on the American position, which was the most depressed. For Brazil, *Econ.* Oct. 18, 1884, p. 1252.

downward trend of the prices of the most important articles of world trade, which reflected a currency structure cramped by the condition of the gold supply and insufficiently responsive to the growing volume of trade. Such a structure augmented the fall of iron prices, lengthened the period required to make new railway investments and new land development profitable, and added to the burden of loans. Hence currency conditions accentuated the influence of injudicious "development" programmes in reducing export trade.[1]

These facts were patent. But it was also patent that the volume of British exports of iron and steel suffered far more than the volume of German and Belgian exports. German exports rose in 1883 while English trade declined; and both the Continental exports shrank only 10 per cent while the English trade fell off by one-quarter.

TABLE III[2]

Exports of Iron and Steel, 1878–85 (000 English tons)

	1878	1879	1880	1881	1882	1883	1884	1885
Great Britain	2297	2883	3793	3820	4354	4043	3497	3131
Germany ...	746	893	772	891	971	1034	970	948
Belgium ...	269	330	355	360	437	422	411	396
Total	3312	4106	4920	5071	5762	5499	4878	4475

A growing part of the German and Belgian exports went to the expanding markets of South America, the Orient and the British Colonies. "Advices by every mail from India, China, the River Plate, Australia and New Zealand speak of the keenness of the competition of the enterprising manufacturers of the Continent", said a writer in the *Economist* in 1885.[3] It was important, since it was in these markets that England was looking for an outlet to replace the spasmodic and doomed

[1] J. H. Clapham, *Economic History of Modern Britain*, II, pp. 383–5. Giffen's valuable contemporary study of the fall in prices, in *Essays in Finance*, 2nd series, p. 16, is in some ways misleading: he quite misrepresents the price movement in iron and steel by omitting the speculative price rise of 1879–80.

[2] German statistics from *Statistik d. deutschen Reichs*, various volumes; Belgian from *British Iron Trade Association Reports* and *J.I.S. Inst.* various volumes.

[3] *Econ.* July 11, 1885, p. 841.

American demand, which had slumped again by 1885—to 400,000 tons. A complete statistical picture of the Continental advance into the new markets is probably not obtainable,[1] but its importance is readily illustrated. For instance, of the large Belgian export of bar and section iron in 1885, whose total was 225,000 tons (of which 55,000 tons came to England), over 20 per cent went to distant, non-European markets, excluding the United States.[2] By the same year the German export to Australia, which was 600 tons in 1880, had reached 28,000 tons; corresponding figures for China were 3500 and 12,000 tons; for Japan, 500 and 11,500 tons; for India—less important—400 and 2400 tons; for South America, 6600 and 40,000 tons.[3] Save in Japan and China these Continental exports were still pigmy trades compared with the English exports to the same markets: England's trade to the chief South American markets, for instance, rose from 160,000 tons in 1880 to 270,000 in 1885, with an intervening peak of 370,000; figures which show that the British commercial organisations were not asleep. For all that the Continental successes remained significant; England had had the great advantage of being the "man in possession", and for the most part her industry had a more advantageous geographical position for the trades.[4]

"Looking back to the history of the development of the foreign iron trade", wrote Lowthian Bell in a survey for the Royal

[1] There was always a big German export to the Netherlands, of which much was probably in transit to overseas markets.

[2] *Report of British Iron Trade Association*, 1887, pp. 91–3.

[3] *Statistik d. deutschen Reichs*, N.F., Bd. 50–51: *Waarenverkehr...mit den Auslande*, 1880–89. The figures given are totals of the chief items exported to the various markets, and represent correctly the scale and the trend: they are not quite complete.

[4] Probably under 50 per cent of German exports in 1884 went to markets for which German manufacturers were better placed geographically than English makers. The following grouping is suggested:

Privileged Markets		Unprivileged or Unfavourable Markets	
Switzerland ...	48,000	United States	66,000
Austria Hungary	83,000	Great Britain	79,000
Italy	79,000	Other countries outside Europe	71,000
Belgium ...	123,000	Portugal and Spain	48,000
France	84,000	Holland	119,000 (transit)
		German Free Ports (Baltic) ...	53,000 (transit)
		Russia	110,000 (doubtful)

Commission on the Depression of Trade in 1886, "it would almost appear as if insufficient importance had been attached to its progress by the manufacturers of the United Kingdom."[1] The conclusion was irresistible. But almost as Bell wrote, trade began to revive again, and the menace of competition became less disturbing. The initial impulse to recovery came, as so often in the past, from record-breaking railway building in the States. A fresh spasm started in 1886. 13,000 miles of railway were laid in 1887.[2] In that year more iron left England for America than in 1882, much of it in the form of rails or materials for railmaking (steel ingots and hematite pig).[3] America's boom was short-lived. But English iron exporters found compensation in a renewed growth of the iron consumption of those newer overseas markets—South America and South Africa, India and Australia, China and Japan—which had already proved encouraging in the early 'eighties. Sales to these markets scarcely fell off between 1882 and 1885, and they rose again while sales to the United States shrank from 1,200,000 tons in 1887 to 579,000 in 1889. By this date the group of young markets was taking over 2,000,000 tons of English iron and steel, a half of the total British export. Railway and mining enterprise, bridge building and dock construction, fed often by English capital, explained much of this growth.[4]

TABLE IV

Exports of Iron and Steel from the United Kingdom (000 tons)

	1873	1878	1883	1889
To South America (chief markets)	155	128	379	693
China[5] and Japan	27	44	57	118
South Africa	17	31	72	106
Australasia	132	250	399	384
Canada	150	104	232	276
India	81	220	374	468
Total	562	777	1513	2045

[1] Bell, *The Iron Trade*, p. 93. [2] *Econ. Commer. Hist.* for 1888, p. 23.
[3] The export in 1887 was 1,286,000 tons. It was down to 643,000 in 1888.
[4] *Econ. Commer. Hist.* for 1886, pp. 1, 5, 22–3; *Econ.* 1889, pp. 631, 1234.
[5] Including Hong Kong.

This was an encouraging development; for though it did not carry the English export figures so high in the late 'eighties as they had reached in 1882, it gave more promise of security. And it was accompanied by an expansion of home demand. Shipbuilding flourished again, both for home and foreign buyers, the staple engineering industries were enjoying full order books, there were more new ships than usual for the navy, and new industrial demands for iron were rising fast, particularly in the electrical industry.[1] There were plans for a tower in London more monstrous than the Eiffel Tower.[2] Never in any country had the output of steel ingots risen so fast as in England between 1886 and 1889.

The later 'eighties were prosperous for the Continental iron and steelmakers as for the British; but prosperity was not marked by rapidly growing exports. Neither the Belgian nor the German industry experienced an expansion of foreign sales on the scale enjoyed by the English, and in the years of highest prices Germany's exports shrank. The figures were thus reassuring.

TABLE V

Exports of Iron and Steel, 1885–90 (000 English tons)

	1885	1886	1887	1888	1889	1890
Great Britain	3131	3388	4143	3967	4186	4001
Germany ...	948	1131	1174	970	985	943
Belgium ...	396	434	442	465	533	470
Total	4475	4953	5759	5402	5704	5414

With the new decade the trend of trade rapidly changed; the mood of confidence which veiled the growth of competition was dispelled, and throughout the 'nineties it rarely, and never robustly, revived. The first four years of the decade were universally years of reaction from the exuberant and often ill-judged capital expansion of the late 'eighties. Iron prices fell everywhere. But the impact of these depression years was more severe on the English than on the Continental industry. English

[1] *Econ. Commer. Hist.* for 1887–8–9, *passim*.

[2] *Ibid.* for , p. 21.

exports fell by almost 40 per cent in the three years after 1889 and remained down. Belgian exports fell by less than 20 per cent. Germany's export almost regained its former volume by 1891, passed it in 1893 and then rose fast.[1] For all three producers home consumption at this time, in so far as it can be measured from the statistics which are available, was approximately stationary or slowly rising;[2] and this allowed both Belgium and Germany to increase their pig output slightly and their steel output considerably. Steel was quickly displacing malleable iron. So in Germany ingot production mounted throughout the depression, taking the European lead in 1893, equalling England's former maximum in the next year, and establishing a new European record in 1895. In England, home demand and the superseding of puddling were not enough to compensate for the export losses; from 1891 to 1895 ingot production was below the peak of 1890.[3]

By the close of 1895 a new period of expansion had opened—the third since 1878—and for the second half of the decade British ironmakers were more prosperous. But for most of this time the British export was becoming proportionately less important in world trade. England's export shot up characteristically in 1895–6, to the delight of those who had for long resisted panaceas

[1] The figures are given in Table VI, p. 84.

[2] Comprehensive estimates of consumption can only be deduced by subtracting from statistics of pig-iron production the net iron and steel exports, converted into "pig-iron" terms (assuming e.g. that 1 ton of finished iron represents 1·33 tons of pig iron). The figures should be corrected by allowing for changes in pig-iron stocks, but stock statistics are unsatisfactory. Estimates on these bases for England and Germany given in the *Rep. Tariff Comm.*, and in Kestner, *op. cit.* p. 132, are as follows:

	1889	1890	1891	1892	1893	1894	1895
England ...	3359	3079	3430	3404	3282	4216	4304
Germany ...	3543	3921	3449	3713	3659	3748	3659

[3] The U.S. had passed England—permanently—in 1890. The figures (000,000 tons) are:

	1889	1890	1893	1894	1895	1896
United Kingdom ...	3·57	3·58	2·95	3·11	3·26	4·13
Germany	1·96	2·10	2·98	3·56	3·83	4·63
United States	3·39	4·28	4·02	4·41	6·11	5·28
Belgium	0·26	0·22	0·27	0·40	0·45	0·59

and refused to despair.[1] When Lord Rosebery, in the midst of the export revival, declared "I am afraid of Germany"—thinking of her system of technical and commercial education—he was quite out of tune; Chamberlain, retorting, was "glad of the competition which keeps us alert".[2] But the promise of 1896 was not fulfilled. There was no appreciable growth in England's export from 1897 to 1900. More pig iron was sold abroad, but orders for manufactured iron and steel products were either stationary or falling.[3] 1899–1900 were boom years, but it was a price movement only.

The trend of German and Belgian exports after 1896 was not more favourable than the English trend, though both these countries in 1898 established new records, and both were consolidating their trade at its highest level. It was not their achievements, however, which in these years lessened England's relative importance in world markets, but the whirlwind progress as an exporter of the United States, virtually a newcomer to the international iron trade and hitherto deemed incapable of competing outside her tariff walls. In 1894 it had been remarked that for the first time American prices had fallen below English at the lowest point of the depression;[4] and in 1896, when American exports were noticeably growing, the trend was treated as a sign of dull home trade.[5] Through 1897 American prices and exports both mounted, and it was realised that the basis of the export was more substantial than had at first been supposed.[6] The upward movement was continuous and rapid; by 1900 the export from the States exceeded 1,000,000 tons and, having well passed the Belgian figure, seemed to be about to rival the German. Table VI (p. 84) gives the figures.

"There is always a liability to exaggerate the dangers of industrial rivalry, and some at least of our metallurgical in-

[1] See e.g. *Econ.* Oct. 24, 1896, p. 1385: "Our manufacturers may not always show the maximum of energy, but as soon as ever they seriously feel the pressure of foreign competition they take steps to neutralise it. While they can do this, there need be no cause for alarm. When they fail...it will be too late to find a remedy."

[2] *Ibid.*

[3] Below, p. 84.

[4] *Econ.* Jan. 4, 1896, p. 4.

[5] *Ibid.* Jan. 16, 1897, p. 77.

[6] *Econ. Commer. Hist.* for 1897, pp. 21 sqq.

dustries have been a great deal more frightened than hurt", wrote the *Economist* towards the close of 1896.[1] If the export trends of the first half of the decade are examined in the light of the fluctuations in the consumption of different geographical areas, some justification for this view is found. The figures of Table VI give an unduly dramatic picture of the differences of exporting power which the early 'nineties revealed.

TABLE VI

Exports of Iron and Steel, 1890–1900 (000 English tons)

	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
Great Britain	4001	3129	2633	2738	2567	2738	3423	3599	3160	3601	3447
Germany ...	943	1148	1116	1194	1417	1504	1495	1371	1600	1486	1525
Belgium ...	470	455	450	453	496	491	583	582	590	569	459
United States	—	—	—	—	—	89	205	561	797	894	1154
Total	5414	4732	4199	4385	4480	4822	5706	6113	6147	6550	6585

The chief shrinkage of demand for iron in these years occurred in the markets which had expanded amazingly for England in the preceding decade—the Empire, South America, the Far East. England's exports to these markets dropped from 2·05 million tons in 1889 to 1·05 in 1894.[2] This drop accounted for two-thirds of the decline in English exports; it was over twice as great as the total rise, in all markets, of the Belgian and German export in the same period. The rest of the decline was located mainly in the trades with the United States and with Germany;[3] both were tariff-bound producers, and the American market had been made less receptive for English goods in 1890 by the McKinley tariff.

Distant overseas markets were far less important for the German iron trade than for the English. The Germans found the market for most of their export on the Continent. Now the consumption of the Continent, measured both by the absorption

[1] *Econ.* Nov. 21, 1896, p. 1525.

[2] Details (000 tons) for 1894: South America, 217; China and Japan, 160; South Africa, 89; Australia, 188; Canada, 119; India, 292.

[3] Exports to U.S. dropped from 500,000 tons to 200,000 between 1889 and 1894; and the trade with Germany and Holland from 650,000 to 433,000.

of products from the chief exporters and by the statistics of pig-iron and steel output, rose between 1889 and 1894, in contrast with the consumption of the distant markets. The circumstance was particularly valuable for Germany, since she had geographical advantages in many sections of the expanding trade. Well over half of the increase in her exports at the time occurred in the European trade, and most of it in trade with neighbours. Of an increase of 200,000 tons in the German export to the Continent of bars and sections, plates, sheets, rails and wire,[1] France took 20,000 tons, Austria 17,000, Switzerland 40,000, and Russia, with whom a more favourable commercial treaty was made in 1894, 85,000. England's trade with Europe fell off while that of Germany rose; but if the export of pig iron be disregarded (it was largely a trade with Germany) the total trade was stationary; there was a falling off in most malleable iron exports and in the rail trade—where Germans were gaining—but this was compensated for by a rise in exports of steel sheets and bars and tinplates.

These elements in the regional analysis of the trade statistics of the early 'nineties certainly suggest less weakness in the competitive capacity of England's iron industry than the crude export totals. But there are other elements where weakness appears. For both the Belgian and German exporters increased their sales in the overseas markets where England lost heavily, and the Germans pushed farther into the British home market itself. In the Asiatic, South American and Imperial markets, whose consumption of England's iron dropped by a million

[1] These were the most important items with the exception of pig iron. The changes in the composition of the German export are shown in the following table:

	1880	1885	1889	1894	1900
Pig Iron	208	214	156	155	129
Bar Iron	151	154	167	301	173
Angles and Sections ...	7	18	51	130	216
Rails	230	165	111	119	156
Wire	105	193	156	210	170
Sheets and plates ...	38	44	62	90	167

Iron and steel exports are not distinguished in the official statistics. It is likely that by 1890 rails, angles, sections, and wire were already mainly steel.

tons between 1889 and 1894, German sales rose from 120,000 tons to 180,000 tons.[1] Most of the tonnage was made up of bars and wire, particularly galvanised wire; in these markets Germany sold four times as much wire as England in 1894 and half as much bar. Belgian trade similarly advanced. In India, for example, her trade was more important than Germany's, but between 1889 and 1894 she rapidly overtook and passed England as a provider of steel there, selling 28,000 tons in the later year. By that year England was consuming 70,000 tons more of German iron and steel—mainly angles, sections and girders, wire and rails—than she had during the boom. The tonnage of Belgian iron and steel which she consumed fell slightly in this period but remained important: more than half of it was composed of beams and girders.[2] When Henry Simon, the Manchester engineer, built new-style coke ovens at a Middlesbrough blast-furnace plant in 1896 he used Belgian girders; and when he was taken to task for it he could point to the Belgian girders of Middlesbrough station.[3]

The years 1890–4 were years of exceptional shrinkage in markets where English trade flourished, and the latter part of the decade witnessed only a partial recovery in these markets. This helps to explain the stationary nature of English exports, and, to a less degree, of Continental exports, after 1896. But just as the situation in the early 'nineties showed a real English weakness in face of Continental competition, so from 1896 to 1900 the English industry was unable to take full advantage of what recovery occurred in the distant overseas markets because of American activity, and it lost ground before American importers in providing for home consumers. In South America, Japan, China, Australia, South Africa, and above all Canada, the United States producers made appreciable headway—

[1] The German figures for these trades in 1889 was higher than in any earlier year in the 'eighties, although there had been a fall in Germany's total export to all markets from 1887 to 1889. Between 1889 and 1894 Germany's export to South America rose inappreciably; there was considerable increase in trade with India, Australia and Japan.

[2] The German figures (from German sources) were: 1889, 49,000 tons; 1894, 121,000 tons. For Belgium: 1889, 108,000 tons; 1894, 94,000 tons.

[3] *Engineer*, Jan. 24, 1896, p. 96.

generally more than the English made—in the sale of the common heavy iron and steel products: pig iron, rails, bars, girders, sheets, wire, etc.[1] They also successfully opened up markets in Europe, finding an outlet for their pig iron in Germany and the Mediterranean ports. They sold pig iron to England also; southern pig from Alabama, which found cheap freights in the cotton ships.[2] The Continent had always imported pig, usually English pig; but it was a new thing for England to import pig iron of common quality. There was another novel element in the American trade with England, for it included a rapidly growing tonnage of semi-products, steel billets for re-rolling into sheets and bars. A little came from Europe as well; but out of a total of 40,000 tons of "semis" imported in 1897 the American contribution was 26,000 tons; it was 59,000 out of 77,000 in 1899 and 158,000 out of 179,000 in the following year. By this time the States were also sending other products: ship plates to Glasgow and the Tyne, and wire, and wire nails.

Though the last year of the decade was one of great prosperity for the iron and steel industry, and prices early in 1900 were such as "had not been known for 25 years",[3] the 'nineties had been unmistakably disturbing. Even the optimistic *Economist* allowed itself an occasional regret that the English industry had made no recent advance in size.[4] In the first four years of the new century the menacing trends of the 'nineties were accentuated.

The first unfavourable movement occurred in April 1900. Iron prices collapsed in the United States, where the expansive trend of markets had been reversed.[5] Makers at once tried to dispose of an increasing tonnage in their growing export markets. England's import of American "semis" leapt up, and Germany and Belgium, also increasingly invaded, were filled with fear.[6]

In the following year the position swiftly changed. America's

[1] For the distribution of American trade, Beck, *op. cit.* p. 1340; and *Rep. Tariff Comm.* Tables 45–9.
[2] *Econ. Commer. Hist.* for 1897, pp. 21 sqq.
[3] *Econ.* April 7, 1900, p. 492.
[4] *Ibid.*
[5] *Econ.* July 4, 1900, p. 945.
[6] G. de Leneer, *Les Syndicats Industriels en Belgique*, p. 183; A.-E. Sayous, *La Crise Allemande de* 1900–1902, pp. 142–3.

check had proved momentary only; by the close of 1901 she was absorbing European iron as well as her own production and prices were bounding up.[1] But Germany had by this date plunged into the most intense depression which she had experienced since the 'seventies. From 1895 her industrial expansion had become ever more intense and excited. It was most violent in the electrical industry, with rival manufacturers promoting the finance as well as supplying the equipment for tramway and lighting installations.[2] But rapid expansion was universal. Growing population and rising wage rates increased consumption and stimulated speculation, and gave work to the factory builders and the machine makers; the pace of railway extension rose,[3] and the young steel shipbuilding industry made notable headway. Most forms of the development expanded the market of the producers of iron and steel, and the internal consumption in Germany of the basic metal, in so far as it can be measured, almost doubled between 1895 and 1900;[4] a growth made possible partly by bigger imports, but mainly by additional ironworks' plant. In the latter half of 1900 it became clear that the prodigious advance had in many directions been unhealthy and misjudged; capital equipment had been augmented far more rapidly than the effective demand for industrial products. Abounding stocks and empty order books brought prices tumbling, stopped factory building, destroyed credit and broke banks, and ruined the speculators in shares and commodities.[5] Inevitably the ironmakers were hit with particular severity, and the German home market, which had absorbed 130 kilos of iron per head of population in 1899 and 1900, took only 90 in 1901 and 77 in 1902.[6]

[1] *Econ.* Dec. 20, 1902, p. 1977.

[2] A brilliant contemporary account of the German situation is given by Sayous, *op. cit.* The electrical position is dealt with on pp. 11–13. The greater part of the book is concerned with coal, iron and steel: particularly with the operation of the Kartells.

[3] Railway statistics in Beck, *op. cit.* p. 1387.

[4] Kestner, *op. cit.* p. 132, gives the following figures: 1895, 3,741,000 tons; 1898, 5,659,000; 1900, 7,555,000. Possibly the latter tonnage exceeded real needs: the figure for 1899 was, however, almost 7,000,000.

[5] Sayous, *op. cit.* pp. 22–3.

[6] E. de Billy and J. Milius, *Revue de Métallurgie*, 1904, p. 107.

By the autumn of 1900 German iron prices began to fall, and like the American makers earlier in the year the Germans turned to the export market. Through 1901 this became increasingly characteristic.[1] Partly it rose from the efforts of firms which had long contracts for the purchase at boom prices of ore, coke, pig iron or steel billets to unload stocks and cut their losses.[2] But mainly it reflected the efforts of enlarged firms to avoid working far below the capacity of their plants. For many products the home market was organised, prices were fixed and sales regulated according to quotas; extension of sales must be found in foreign markets, where prices were uncontrolled. In some cases exports were encouraged by a system of bounties, paid by the home price- and quota-fixing Kartells.[3] Under the influence of these events and policies Germany's export of iron and steel in 1901 was almost double that in 1900, and in 1902 it was double the previous maximum (1898). Of the increase between 1900 and 1902, over one-third was sold in England, whose purchases of the heavy products rose from 136,000 tons to 714,000 in these years.[4] Most of the remainder of the increase was sold in Europe, but non-European overseas markets expanded by over 300,000 tons, growing at a greater rate than those on the Continent.

While Germany's export bounded up from 1900 to 1903, England's fell sharply in 1901 and then recovered its original level in 1902–3. If the export of pig iron is neglected, a trade in which shrinking markets were more important than competing export supplies, the fall of 1901 was slight and thereafter there

[1] See Table VII, p. 93.
[2] Sayous, *op. cit.* pp. 118–20, 183–6, 201–2.
[3] The operations of the Kartells are discussed more fully below.
[4] Imports of German Steel into England (000 tons):

	1900	1901	1902	1903
Angles and sections ...	47	114	122	153
Semis	—	112	363	391
Bars	6	43	55	43
Rails	24	38	55	64
Wire nails	14	17	13	14
Wire	43	56	64	44
Plates	2	23	42	41
Total	136	403	714	750

was a rise: the export of "finished products" rose from 1,926,000 tons in 1900 to 2,358,000 in 1903. America was out of the market as a seller to a large extent, and most markets consuming "finished exports", having escaped the acute crisis which had overcome Germany, were slowly growing. So long as the export of finished iron and steel products was treated as a homogeneous trade, the influence of the German industry's successful export policy might thus be regarded as moderating but not preventing the expansion of the English export in face of growing markets.[1] Observation of more detailed statistics shows that the process was more subtle. There were some branches of the export where England lost much in 1901 and Germany gained more—in iron and steel bars and angles, and plates and sheets "not under ⅛ inch thick". In 1903 the English trades in these commodities were still below their level of 1900, but Germany had gone further ahead, and sold a big tonnage of the commodities in the English market.[2] Decline in these branches of the English export was more than offset by a rise in others. Most important in tonnage was a rise in export of "railway iron" from 464,000 tons to 723,000—well below its former maximum. More significant were increases in a group of trades headed by the galvanised sheet trade (whose export rose by over 100,000 tons), and including those in tinplates, wire, and wrought iron and steel tubes (which rose collectively by 50,000 tons). Makers of these products were using large quantities of cheap imported semi-products—billets, tinplate bars, tube strip[3]—which after the American period came in still larger quantities from Germany and Belgium. One-half of Germany's export to England in 1902 and 1903 was composed of these semi-products, backed by bounties organised by four

[1] The *Economist* stresses this. See *Econ. Commer. Hist.* for 1903, p. 30.

[2] The figures (000 tons) were:

		1900	1903	
Angles, bars, rods	...	300	286	(Eng.)
		389	770	(Ger.)
Plates, etc. ...	...	192	161	(Eng.)
		167	279	(Ger.)

[3] E.g. *Rep. Tariff Comm.* §§ 797, 874, 891, 898, 923.

Kartells.[1] By placing obstacles in some channels and widening others German exporters were moulding the content of the English trade.

Competition was most severe in Europe. England's export to the Continent shrank from 1,900,000 tons in 1900 to 934,000 in 1903. This was partly due to the contraction of Germany's purchase, and the continued growth of protected industries, like that of Russia; but Germany was advancing at England's expense in most European countries, including those where England had hitherto been very strong and sometimes dominant —Scandinavia, Denmark, Italy. But the competition was ubiquitous. In the United States Germany gained as much as England between 1901 and 1903; in Canada it was the same; in South America and in the Far East she gained considerably more. In India her gain was half the English. In South Africa alone of the markets in which England gained much at this time was the German advance slight.[2] England's expansion, if the spasmodic American market be neglected, was very largely within the Empire; but when there was a demand for the commodities of which Germany was a strong exporter the Imperial bonds, sentimental, racial or linguistic, presented usually only an erratic barrier to the Continental advance.

Belgian exporters suffered, like the English, from American and German activities in 1900–1. Thereafter, like the English,

[1] The German figures for 1902–3 are 363,000 and 391,000 tons. The Kartells were the Westfälisches Koksyndikat, the Rheinisch Westfälischen Kohlensyndikat, the Roheisenverband, and the Halbzeugverband.

[2] British and German exports (000 tons) to:

		Sweden	Denmark	Italy	U.S.	S. Amer.*
British: 1900	...	111	64	169	134	232
1903	...	94	46	121	426	252
German: 1900	...	32	51	71	10	90
1903	...	70	86	133	297	181

		Far East*	Canada	India	S. Africa	Australia*
British: 1900	...	197	79	346	118	348
1903	...	213	290	490	364	316
German: 1900	...	60	0·4	31	3	43
1903	...	98	71	100	17	55

* For territorial definitions see Table IV.

they recovered, but with far more vigour. From 1900 to 1903 the Belgian "finished product"[1] export rose by 360,000 tons, comparing well with the English figure of 430,000. By 1902 the previous maximum (1898) was well passed; in 1903 it was passed by nearly 40 per cent. The composition of the export was not modified in face of German advance as the English was; the chief change was a big rise in the rail export, a trade where Germans competed strongly. Merchant iron and steel remained the chief export and touched a new record in 1903 (300,000, as against 190,000 in 1900, and 270,000 in 1897); the girder trade held its position, plates slightly improved. Billets and wire rods were exported in small quantities only, though rising.[2] Like the English, the Belgian trade found less room in Europe; 55 per cent went to markets outside Europe in 1902 compared with 32 per cent in 1898; of this the United States took 94,000 tons, and the other overseas countries took 251,000 tons (instead of 183,000 in 1898). The rise occurred mainly in the United States, South America and India. In China and Japan Belgian trade was stationary while the Germans gained, and it figured little in the British Dominions;[3] in England itself, however, it again made great advances.

Autumn 1903 brought the third swift change of the new century in the iron trade. Hitherto intense American exporting and intense Continental exporting had occurred separately; now they coincided. Vast home demand had provoked an increase in American pig-iron and steel production in the years 1901–3 to 30 and 40 per cent respectively above their previous maxima.[4] By the end of this period the market was saturated; prices broke, and the industry again sought an outlet in the export trade.[5] It adopted frankly (not for the first time) the same policy as the German exporters, sales abroad at prices far

[1] I.e. total export less export of pig iron.

[2] *Rylands Iron Trade Circular, Supplement*, Feb. 7, 1914, gives statistics of Belgian exports, 1895–1913, analysed according to commodities, but not markets.

[3] E. de Billy and J. Milius, *op. cit.* pp. 114–16.

[4] Pig-iron production was 13·8 million tons in 1900, 18·0 in 1903. Steel ingot production was 10·6 in 1899 and 14·9 in 1902.

[5] *Econ.* Oct. 17, 1903.

below home prices, and below total costs, with a view to disposing of stocks or keeping plant well occupied. For the conduct of the policy the industry was better equipped than hitherto. In 1901 a new trust, the United States Steel Corporation—the biggest concern in the world save the Prussian State Railways—obtained a dominating position, and in 1903 it established a subsidiary company to develop its export business. Charles Schwab was menacing. Large orders for billets were secured in England in November 1903 at prices below the German dumping price; the market was "demoralised", and prices of all products fell early in 1904 to a lower level than had hitherto been touched since 1898.[1] Through 1904 the exports of the European countries all fell—England's by 300,000 tons, Germany's by 600,000, Belgium's by 80,000. All of England's and Belgium's losses and almost half of Germany's were accounted for by the loss of the American market; for the rest, America's export gain was more than the remainder of the European export loss. England's import continued to rise.[2] The following table shows the movement of the "total export" figures in the first five years of the new century.

TABLE VII

Exports of Iron and Steel, 1900–4 (000 tons)

	1900	1901	1902	1903	1904
United Kingdom ...	3447	2813	3474	3565	3263
Germany	1525	2329	3279	3439	2706
Belgium	416	481	625	793	716
United States ...	1154	701	372	327	1168
Total	6542	6324	7750	8124	7853

1903 saw a deterioration in English home consumption of iron as well as a new eruption in international trade. The South African war demand had gone. And there were too many disturbing factors to allow the quick post-war revival for which many hoped.[3] Germany had still to recover internally, and

[1] E. de Billy and J. Milius, *op. cit.* p. 119. There is a fuller treatment of price movements below, ch. VII.

[2] It approached 1,200,000 tons in 1904.

[3] For the depression of 1903–4 cp. *Econ. Commer. Hist.* for 1903 and 1904, *passim.*

dumped vigorously meanwhile. America's markets closed. There were war clouds in Japan and a financial crisis on the Rand. Freights fell, and shipowners discovered—it was an old story—that new building in the boom which culminated in 1901 had been overdone. Taxation remained up, the volume of new industrial issues went down. Demands of structural and mechanical and shipbuilding engineers contracted. Sectional discomfort, which had accompanied Germany's export policy, now was succeeded by unmistakable depression in the iron industry. It was bound to come, the *Economist* pointed out, after the prosperous days of 1899–1900.[1]

But the same journal also noted that the English industry was, in an increasing measure, dancing to the tune of foreign producers, not of foreign buyers: and the tune was uncomfortably syncopated.[2] The successive waves of foreign exports which swept across the iron markets of the world were signs of a real crisis in the history of English ironmaking. Competition could no longer be regarded as a series of frontier skirmishes: outlying provinces were the objects of massed invasion, and there were attacks on the capital. The rapid advance of production and export which had been the glory of much of Victoria's reign had ceased during the last twenty years. Was the old organisation of the industry and of the nation adequate for current conditions? Joseph Chamberlain, assuming leadership of the Tariff Reformers, carried the question easily into the front of British politics.

[1] *Econ. Commer. Hist.* for 1903, p. 30.
[2] *Ibid.* Oct. 8, 1904, p. 1615.

Chapter VI

THE TARIFF-REFORM ANALYSIS

The view which Chamberlain sponsored, thereby bringing the controversy concerning the state of iron and steelmaking into the centre of the most passionate political conflict of the time, gave a seductively simple explanation of the accelerating relative decline of the English industry. Though many tributaries swelled its influence, the main source of English discomfiture, according to this view, was to be found in the disparity between the English tariff system and those which sheltered rival producers. The protective duties of Germany and the States had first allowed the indigenous producers to gain their home market at the expense of British imports, and later allowed them to challenge the British maker in neutral markets and finally in his home market. For protection allowed them the continuous exercise of a two-price policy—high prices at home, low prices for export—while the unprotected English maker could only adopt such a policy as an exceptional expedient. This ability of rivals in fixing prices always to discriminate favourably for foreign buyers constituted, it was suggested, the main and sufficient explanation of the recent trends of trade: the position could be at once rectified if English statesmen returned to the protectionist fold.

The kernel of the Tariff Reformers' case—which was expounded with authority though without grace or polish in the Reports of the Tariff Commission, a body of Chamberlain's supporters who, at his request, examined his fiscal plans[1]—lay in the demonstration that in some circumstances it would be an advantage for protected producers to sell for long periods in the export market at prices fixed "irrespective of cost"; that such a

[1] The first *Report* of the Commission, published in July 1904, dealt with the Iron and Steel Trades. This report is referred to in the notes as *Rep. Tariff Comm.* The main treatment of dumping is contained in §§ 62–75.

policy need not merely reduce losses, but would actually be "lucrative". Once it was established that dumping might pay it was an easy, though not logical, step to the belief that all foreign exports were dumped, and to the sophistry that since this alleged dumping trade was profitable it would encourage foreigners to extend their export capacity, "to the final extinction of the English industry", as *The Times* had it.[1]

Shorn of its superstructure the fundamental thesis here was sound and important. It was indeed proclaimed quite frankly by the offending steelmakers themselves before two official inquiries: in the United States before the Industrial Commission which was surveying the labour problem, and in Germany before a commission investigating the influence of Kartells. Provided, so ran the argument, that protected producers, acting in concert, were selling at the most advantageous price in the home market—the price which gave the biggest margin between earnings and prime costs on total home sales—and that their plant was not fully occupied, it would for two reasons normally be advantageous to sell abroad at prices which for a whole output would not be remunerative. In the first place, if the prices more than covered the prime costs of producing the specific commodities sold (i.e. the cost of labour, fuel, materials and short-period repairs) they made some contribution to the fixed or relatively fixed charges which a factory necessarily incurs: depreciation, interest on loans, property taxes, and those parts of selling costs, expenses of administration, and maintenance costs which cannot be reduced if the firm is to remain a going concern. By their contribution they relieved the home sales of some of this burden. This fact had been a recognised basis of the spasmodic dumping which in the past had been practised by the English industry. There was a second, more subtle, point. For it often happened that the prime costs of production (per ton) fell in a plant as the output rose, and vice versa, being least when the plant was continuously and fully occupied. The Tariff Commission published an instance where the labour-cost in converting pig iron into steel rose from 14*s*. 6*d*. per ton to 17*s*. 3*d*.

[1] Leader in *The Times*, July 21, 1904.

when the output fell from full capacity by 25 per cent: while fuel rose from 6*s*. to 8*s*.[1] The sources of this type of variation were manifold. There were many places in a plant where the manning could not be reduced *pari passu* with the output. So long as a power plant was working, for instance, to supply the hot blast to a furnace, the number of persons to supervise it would not vary though the pressure of the blast might be lessened. Maintenance staffs fell with the fall of output, but not in the same proportion. Fuel costs would rise when output fell, partly because power would be continuously available for intermittent use, or engines would be run below the point at which they reached maximum thermal efficiency, or the initial expenses of raising power or starting a furnace would occur more frequently. Sometimes decreased continuity of operations meant an increase in the rate of deterioration of furnace linings. Against additional costs of this type there might be compensations. The labour dispensed with would be the least efficient, and at times a plant working at full pressure might save capital costs by a somewhat prodigal use of fuel. The general experience, however, appears to have been that prime costs rise with falling output.[2] Where this occurred it increased the possible range of price discrimination; for export prices, to be profitable, need only exceed the average prime cost of the goods exported, which would be below the average for the whole output. This condition increased the power of the protected producer to force down the prices obtained by unprotected rivals—in *all* their markets—while he himself added to his profits by "forcing" exports. In general, the protected producer was clearly able to reduce the general level of his unprotected rivals' receipts, and to involve them in one at least of two further injuries—a greater *fluctuation* of average receipts, or a greater fluctuation of output.

No one doubted this element of the Tariff Reformers' case—that a tariff assisted in the disposal of the products of plant capacity which the home market could not employ. But it was fallacious to deduce from this, as was constantly done by the

[1] *Rep. Tariff Comm.* § 56.

[2] The problem of the variation of prime costs is dealt with in Appendix II.

zealots, that the profitability of dumping abroad when surplus capacity existed would encourage the creation of more surplus capacity with a view to greater dumping. For long-period dumping remained, after the most impressive apologia, merely the lesser of two evils, both to be avoided. It was fallacious also to assume that groups of producers who were in a position to dump would be likely deliberately to attack the British industry with a view to destroying it. Unless ultimately the attacking party obtained monopolistic advantages in British markets and not merely the absence of one combatant, the expensive effort of destruction would be valueless. The Tariff Reformers neglected the obvious importance of this, and their crude argument allowed the Free Traders to score easily. Yet there were signs, in fact, that international Kartells were not out of reach for the industry; and once there was a reasonable prospect that such might be formed, deliberate destruction was conceivable. The International Railmakers' Association was revived in the early nineteen-hundreds, and German makers discussed freely the possibility of more extensive international organisation. What were the chances of success? Did the necessary conditions for successful Kartellisation exist in the international steel trade? It was a vital problem in the discussion of dumping, but not seriously examined by either party. And there was another basis on which a presumption that protected producers were likely increasingly to resort to dumping might rest, which was also neglected by both parties to the dispute. The rapid growth of the protected markets encouraged much competitive building, the erection of new plants and the expansion of old. But since to be efficient new plants were necessarily of high capacity, since also effective improvement of old plants involved considerable increases of capacity, there was clearly a danger that capacity would tend to grow faster than demand. No doubt—in Germany at least—the export market was recognised as a safety-valve; nevertheless the growth of export surplus in these circumstances was to be regarded as essentially an incidental effect rather than as an object of expansion. Such a situation was diagnosed from time to time both in Germany and

America.[1] And in both countries home consumption was growing so fast that even a small disparity between the growth of demand and of capacity might lead to the creation of surplus very disturbing for British makers.

The Tariff Reform case could thus not be dismissed by considerations of a general nature though it incorporated crude sophistry. But neither could it by those means be proven. What was its factual basis? How far and for how long had the policy of tariff-fed price discrimination and dumping been a serious incident in the iron and steel trades? Could its habits of growth be traced? And, from a different standpoint, was the probable influence of tariff inequality greater than that of other influences which militated against the success of the English industry? For it was not denied, there were other influences: the nature of the labour supply, the character of the home market, lack of sufficient scientific training ("We are fighting", said Haldane, "like dervishes against Maxims"[2]), oldness of plant, changing conditions of ore supply, dearness of transport: these were universally recognised, and the less kindly critics added other factors—the unsuitable sites of older works, and the inflexibility of the industry in face of new circumstances. Matched against these, in what sense was the tariff situation the determining factor, as the protectionist view implied—was it the most recent factor, or the biggest, did it outweigh the others collectively—or was it rather the most easily remedied, the one cause of distress which could be easily and quickly changed without much disturbance in the industry?

Such problems were, inevitably, a paradise for the dialecticians who deal solely in generalities, and who seek by the congenial and often simple process of qualitative analysis to establish the relative values of conflicting forces, and so to arrive at "rational" preferences without the quantitative study which is vital. And though most contemporary disputants embellished

[1] E.g. *Econ.* Sept. 20, 1890, p. 1199, and below, pp. 279–81.

[2] *The Times*, Oct. 23, 1901: report of a speech at the University of Liverpool. See also his speeches in the debates on the Education Bill of 1902, *Hansard*, 3rd series, CV, pp. 900 sqq. and CVII, pp. 703 sqq.

their arguments with such apposite, albeit ill-digested, statistics as came easily to hand, none, whether inside or outside the industry, made any attempt at a comprehensive study, and the copious information which was available was neither collected nor sifted. In the five chapters which follow, this evidence—supplemented in a few particulars—is examined in detail, first in its bearing on those problems most susceptible of statistical treatment—price movements and discrimination, wage rates and labour costs, raw-material costs and prices—then in relation to the less tangible problems of technological and structural adaptation: and it goes far to supply the answers to the questions which have been posed.

Chapter VII

PRICES

It was curious and symbolic that none of the disputants of the Tariff Commission days published a rigorous study of the price history of the industry, in spite of its significance for the reformers' argument. Even the Board of Trade, in its work of publishing information to illuminate the sources of foreign competition, only touched the fringe of the problem of prices. It was not to be doubted, the officials of the Board allowed, that Kartells followed a two-price policy "in a time of depression"; and it was theoretically possible that a Kartell might set out by such a policy to destroy a British industry, but there was "no evidence" of such a policy in fact. Such price discrimination as occurred resulted from "the novel circumstance" of intense German over-production "in this critical period...of supply exceeding demand in the German domestic market". The position thus stated had a short-period air about it. When the exacting question was put, What degree of price discrimination had occurred? no precise answer could be given. Information derived from isolated instances almost always came from German sources unfavourable to the Kartells, and was therefore suspect; moreover, if it were true it was probably unrepresentative, relating to a small proportion of transactions only. Statements of the course of average prices over long periods, on the other hand, "necessarily rested upon the information supplied by the German combinations, difficult to verify and given by persons unwilling to help the German consumers in their complaints".[1] So the problem must remain obscure.

But the Board's inquiry was far from exhaustive. Actually, in the few instances where Kartells in the industry published what they described as "realised" prices, these were considerably

[1] *Report of Board of Trade on British and Foreign Trade and Industrial Conditions*, 1903, pp. 297–8.

above the international price level and to that extent supported the consumers' complaints. So, too, were the prices "fixed" by Kartells and quoted in the Press. Were these prices normally realised? This was a problem which deserved examination but was not in fact tackled by the Board or by other contemporaries. Nor was it discovered that there were official German publications which helped very materially at some stages of the inquiry into prices; namely, valuations of the output of the iron and steel industry in the 'eighties and early 'nineties, which gave useful indications of the prices of pig iron and semi-products, and records of the average prices paid for rails by the German state railways throughout the pre-war period back into the 'eighties. These figures, more particularly the second, might have served a dual purpose, being valuable objectively and indicative of the accuracy of the Press price quotations. Once home prices in Germany could be established with some confidence there were guides to the export prices of several commodities to form this basis of a comparison. A discriminating interpretation of foreign trade statistics could reveal important information for several products, which could be checked against the British and Belgian figures. Belgian prices were in fact, along with most other aspects of the Belgian industry at this time, almost wholly neglected in British discussions. Belgium having a negligible tariff, her competition was of no interest for the Tariff Reformers; but the Free Traders overlooked it too. The Board of Trade published some information about long-period British price movements,[1] but it did not use this for comparison with German trends, nor did it draw as fully upon its resources—e.g. information in connexion with wages dependent upon price changes—as was possible. It may be noted that all this information could have been brought together by any of the interested parties—the Board had no monopoly of any source of information. Had all these sources been utilised much obscurity could have been dispelled.

In particular, the price history of the rail trade would have been illuminating. Information was abundant, fairly well

[1] *Report on Wholesale and Retail Prices,*

defined, authoritative, and available over a long period; it provided—and still provides—the key to the price problem.

Here are the figures.

Table VIII*

Rail Prices (shillings per ton)

	German home[1] (from Railway Statistics) delivered	German home quoted[2] (at works)	German export[4] (Frontier)	Belgian export[5] (F.O.B.)	British export (F.O.B.)	*Economist*[6] (at works)	British realised[7] (at works)
1881	160	*158*	120	—	131	—	—
1882	164	*154*	130	—	131	—	—
1883	165	*145*	110	—	118	—	—
1884	156	*142*	118	—	114	—	—
1885	148	*138*	110	—	112	—	—
1886	145	*115*	93·5	—	94·5	—	—
1887	130	*108*	92	—	88	—	74
1888	126	*115*	95	—	86·5	—	73
1889	127	*125*	110	—	92·5	—	85
1890	148	*155*	115	*119*	109·5	*116*	100
1891	151	*125*	100	*94*	101	*91*	85
1892	131	*115*	99	*90·5*	88·5	*83·5*	—
1893	125	*110*	84·5	*80*	83	*77*	—
1894	122	*110*	83	*76*	79	*73*	74
1895	116	—	87·5	*76*	76	*75*	70
1896	113	*110*	95·5	*89*	89·5	*92·5*	82
1897	113	*104*[3]	100·5	*90·5*	93·5	*91*	85
1898	115	*108*	105·5	*84·5*	94	*90·5*	86·5
1899	115	*118*	121·5	*108*	99	*107*	95·5
1900	121	*135*	126	*130*	131	*146*	130
1901	124	*110*	111	*103*	117	*111*	110
1902	123	*102·5*	96	*89*	110	*109*	97
1903	116	*117·5*	91·5	*89*	107	*108*	97
1904	118	—	89·5	*83*	97	*90*	88·5
1905	118	—	95·5	*95*	100	*109*	93·5
1906	116	—	104	*101*	112·5	*125·5*	113
1907	117	—	121	*124*	130·5	*134*	125·5
1908	122	—	114·5	*108·5*	121·5	*119·5*	107
1909	123	—	105·5	*102*	113·5	*106*	94[8]
1910	121	—	105·5	*103·5*	115	*116·5*	98
1911	122	—	105·5	—	119	—	—
1912	120	—	111	—	121	—	—
1913	121	—	115·5	—	138	—	—

* The notes to this table are relegated to p. 115.

In Fig. 1[1] the margin between German home and export prices is illustrated graphically. British as well as German export prices are included in the picture, since the German series is probably too high.[2] The margin shown of course exceeds that between home and export prices "at works", which is the significant figure; but a deduction of about 8*s*. will give this.[3] Three facts are brought out impressively by this graph.

1. That for over a quarter of a century the two-price policy had been continuous save for three years (1898–1900) at the most, and that the discrimination between home and export prices was usually considerable, averaging as much as 30*s*. a ton in the years before 1896, though very much less after that date. The fall in this average after 1895 did not, it may be seen from the volume of the trade, indicate a declining desire on the part of the Germans for export trade. In one year of the late 'nineties alone was there a fall in exports, and the enormous expansion of 1902–3 was achieved without resort to the degree of discrimination exercised prior to 1895.

2. The reduced level of discrimination was the result far more of a fall in the home price charged in Germany than of a rise in export prices. From 1880 to 1895 home prices declined notably —by over 20 per cent—and thereafter their trend was very gently upwards, and their fluctuations slight.

3. While the average value of German exports rose slightly more than the home price after the mid-'nineties, the average value of British exports rose far more, so that from 1900 onwards the relation of the two prices was reversed, and the British average in future was continuously and often considerably in excess of the German figure. (In this period it is, of course,

[1] Folded at the back of the book.

[2] The Germans may have obtained a better average price at the frontier than the British F.O.B. when they were selling a large proportion of their rails to their neighbours, especially in the South and East. But it is also likely that their export average was high because the German export included a higher proportion of more expensive types of rail than the British: notably tram rails, a German speciality. From 1895 to 1898 the average price of German rails exported to Great Britain was far above that of British rails exported.

[3] See discussion in notes on Table VIII, p. 115.

the German figure which alone can be a guide to the extent of discrimination practised by the German makers; and it must still be regarded as a slightly high figure.)

To prove that there was a big gap between German home and export prices is not equivalent to proving that export sales were made at prices "below total cost"; but it establishes a strong presumption that dumping of this type occurred. This presumption is supported by other evidence. It is noteworthy, in the first place, that when price discrimination was most acute the firms which were most dependent on the steel-rail trade did not, where their accounts are known, pay high dividends. It is more interesting, however, that where the costs of German makers have been published they sustain the view that dumping occurred at least in the period up to the mid-'nineties. This kind of information is, of course, liable to be misleading: but there are some figures which deserve to be reviewed. The earliest come from the German Tariff Enquiry of 1879. Here, it has been seen, a number of important makers gave their costs for making Bessemer steel rails at figures varying from 110 Marks to 140 Marks a ton—depreciation and interest on capital being included, but not "profit".[1] The lowest figure came from Hoesch, who used imported British pig iron, and was likely to be in favour of Free Trade and therefore to give costs on the low side; the highest figure came from an isolated works with high material costs but a local monopoly. The financial difficulties of the German steelworks at this period, when by price cutting they were pushing their rail export business, makes these cost statistics credible.[2] A second series of figures was collected ten years later (1888–9) by the United States' Commissioner of Labour and published in an elaborate report on comparative

[1] *Protokolle d. Eisen-Enquete Kommission*, p. 2 (Phönix, Ruhrort), p. 232 (Hoesch, Dortmund); p. 387 (Hörde, Dortmund); p. 749 (Maximilianshütte); p. 780 (Bochumer Verein).

[2] English firms were exporting at 95*s*. a ton by 1877, and the Germans came close to it. The average value of British rail exports in 1878 was still 140*s*.; it fell to 116*s*. in 1879, and exports to Italy averaged only 105*s*. 6*d*. This very low figure would have given Westphalia works, which were competing in Italy, about 100*s*. The fortunes of German firms in these years have been dealt with above, Bk I, chs. II, III.

costs in the steel trade,[1] a report which, being drawn up mainly to shed light on labour questions, is described in the following chapter. Its very detailed statistics, be it said in anticipation, appear reliable. Costs (excluding capital cost) are given for six Continental plants making heavy rails. Most were German, and, save for one, all the costs were within a few shillings of each other, averaging 95*s.*[2] To compare with these figures there is a series (which also neglects interest on capital) compiled from the records of a single firm, namely, the Hörde Verein, the pioneer in Germany of the basic process. In 1882 Bessemer rails cost the firm 128*s.* per ton, Thomas rails 120*s.* Two years later the Thomas rail cost was a little above 104*s.* In 1888 the cost had fallen to about 98*s.*, and by 1896 the same mill was making rails at 89*s.*, while a new mill reduced the figure almost to 81*s.* For interest on capital 4*s.* or more should be added and the transport cost on exports from this works was at least 5*s.* 6*d.*[3] If these data are even roughly as accurate as they are consistent

[1] C. D. Wright, *Sixth Annual Report of U.S. Commissioner of Labour*, p. 166. See next chapter, p. 120.

[2] One very low-cost European plant—probably Cockerill's at Seraing—brought the general average down to 93*s.* 4*d.*

[3] H. Ehrenberg, *Die Eisenhüttentechnik und der Deutsche Hüttenarbeiter* (1906), pp. 175–200. These figures were collected ten years after the date of the last cost published, at a time therefore when no propaganda value was attached to them, and in a work concerned with labour problems, not tariffs. The 1882 and 1888 figures are calculated from the cost of ingots, but lower costs had been experienced in the past: e.g. 118*s.* in 1878 (p. 196). The 1884 figure as published (103*s.*) omits some maintenance costs. The details for 1896 are:

Cost (in Marks) of:	Ores	Pig iron	Steel	Fuel	Wages	Other Items	
In 1 ton pig iron	28·7	—	—	10·2	2·9	5·5	(1895)
In 1 ton steel	—	51·4	—	1·7	2·2	6·7	
In 1 ton rails: old mill	—	—	75·4	3·7	6·1	5·5	
new mill	—	—	71·8	3·1	3·6	2·9	
new mill	36·4	—	—	18·2	9·3*	17·2	

* Excluding coke-oven labour.

Where these figures can be checked, on bases indicated in later chapters, they certainly do not appear high, e.g. the transport cost on ores was 18*s.* a ton of iron: no allowance is made for fluxes; coal is reckoned at about 6*s.* per ton *delivered*; and the yield of rails from one ton of ingots is 86 per cent in the new mill, which is high. Hörde costs would be fairly representative for Westphalia; some sites were slightly better, some plants (e.g. Krupp's) far less up-to-date. Hörde had been modernised very recently.

the inference is that the price discrimination up to the 'nineties usually involved sales "below cost", the margin often being quite considerable; and, unless there was a quite remarkable reduction in cost through plant improvement after 1896,[1] it might be inferred that the export prices in the depression after 1900 also were also "below cost".

Some of this cost information was not available to the disputants of 1904–6; the rest was not familiar, and all might have been deemed nebulous. But in the light of the rail-price history alone views commonly held by Free Traders would have appeared perverse, for example Mr (now Sir) S. J. Chapman's, that the policy of dumping "in its recent forms has not been sufficiently well tested to enable an unhesitating judgment to be passed that it will be applied more widely or even retain its present position".[2] The only recent changes had been (*a*) the extension of the policy to more products, (*b*) an increased sale in Britain itself, (*c*) the institution of "export bounties". The rail trade had shown that discrimination could thrive vigorously without bounties, and with this in mind there was a strong presumption, though not a certainty, that the extension of the policy to new products would prove lasting, so long as there were no fundamental changes in the comparative cost situation. That Germans (and Americans too) found it attractive to sell more products in Britain itself, where their transport disadvantage was at its maximum, was an impressive and a curious phenomenon; but it differed not a whit in principle from earlier practice, and could scarcely be dubbed out-of-hand as temporary.

Rail prices thus lent support to one element in the Tariff Reformers' argument. But they are interesting, too, from another angle, since they suggest that a significant change had occurred in relative costs of production. For whereas until 1900 the German makers had invariably obtained for the whole of their rail output an average price considerably above that obtained by the British, after that date they often obtained a

[1] There were some influences tending to raise costs after 1895, e.g. wages rose.

[2] In a review of the *Report of the Tariff Commission* for the *Economic Journal*, 1904, p. 620.

lower average (e.g. in 1900, 1903, 1906 and 1907).[1] Since the German rail trade was expanding after 1900, and export trade grew fast, while the British trade was stationary or retrogressive, it seems likely that after 1900 German costs were rather lower than the British, whereas earlier—especially before 1895—they had probably been higher.[2] Thus the early years of the new century were probably critical in two ways; not only were the German makers driven to make more violent onslaughts in export markets, but they were probably able to do so with a new cost advantage. The signs of this were obscured for contemporaries by the fact that over-expansion had manifestly occurred, and might explain sufficiently the new scale of exports, but they were not invisible. Indeed, the important merchant H. J. Skelton pointed to them in 1903, holding it likely that German firms, which were paying dividends, were obtaining lower average prices than firms, such as Ebbw Vale, which could not, or so they said, make the steel business pay.[3]

No other trade has left such illuminating records as the rail trade. But the price history of one trade alone might be misleading. How does the data available for other trades fit into the pictures which the rail prices suggest? To answer this condition, four trades of varied types may be glanced at, first with regard to the persistence of dumping, secondly with regard to comparative average prices.

[1] To guess the German average approximately a deduction—say of 12*s*. a ton—must be made from the home delivered price and of 5*s*. a ton or more from the export (frontier) price (which, be it recalled, is most likely *above* the figure for heavy rails of normal sections). After 1900 exports were in excess of home purchases. The British realised prices are the best for comparative purposes; unfortunately they are available for a comparatively short spell of years.

[2] This is not to suggest that all firms in either country had the same costs. Indeed some firms *began* making rails in England after 1900—the price obtainable was sufficient to attract some newcomers into the trade. But it was not enough to induce a larger total production, or to induce makers to retain all the old British trade. See next note.

[3] *I.C.T.R.* Dec. 18, 1903, p. 1779. Though it is not germane to the main argument of this chapter it is of interest to observe the different trends of British rail prices in Empire and foreign markets, as shown in the following table. From 1905 to 1908 foreign markets were kept by selling at prices below those obtained in the Empire, where financial, political and engineering contacts were strong. From 1909 the foreign markets were given up very largely; the effort to come down to the German

In the bar trade discrimination in export prices appeared to have been almost as continuous as in the rail trade, and—again a similarity—more acute before than after 1900. The following figures indicate the position broadly:

Table IX

Bar Prices (shillings per ton)

	Westphalian F.O.T. Iron	Westphalian F.O.T. Steel	German export average	Antwerp F.O.B. [1]	British North-East Coast ascertained (iron)
1891–5	115		106	96	108
1896–1900	143		126	120	122
1901–5	121	109	102	100	125
1906–10		118	105	105	133

For the first two periods the Westphalian iron and the Antwerp prices are most appropriately compared; in the last two the

level was given up. It is of interest that all this occurred while the International Railmakers' Association was in being; manifestly the agreement did not rob the German industry of its penetrative capacity.

Tonnage and Average Value of Rail Exports

	U.K. to Empire		U.K. to foreign countries		German	
	Tons (000)	Value (shillings per ton)	Tons (000)	Value (shillings per ton)	Tons (000)	Value (shillings per ton)
1900	191	131	182	122	156	126
1901	266	117	201	118	181	111
1902	299	110	284	108	367	96
1903	383	107	221	106	379	91
1904	294	96	231	97	211	89
1905	268	103	278	96	285	93
1906	218	120	242	106	369	104
1907	225	135	184	127	418	121
1908	214	124	220		331	114
1909	262	114	306	3	365	106
1910	240	113	235	116	516	105
1911	233	117	138	122	520	106
1912	314	118	93	131	523	111
1913	381	134	120	149	501	

[1] De Leneer, *op. cit.* pp. 109–10.

Antwerp price is for steel bar.[1] In the girder trade there was in most years of the 'nineties an export discrimination, averaging about 8*s.* a ton through the decade; but in this trade it was higher, not lower, after 1900. The explanation is simple: for here there was violent competition in the German home market in the mid-'nineties between the Saar works and the Westphalian; from 1898 there was a strong Kartell. In the plate trade discrimination cannot be traced at all before 1900. The average value of German exports was above the quoted price of heavy plates of ordinary quality; and since exports of different types and qualities of plates were not distinguished it is impossible to draw any positive conclusion. After 1900 discrimination occurred and was often acute.[2] In the semi-product trade, also, discrimination can only be traced from the export statistics after 1900; and here it is likely that prior to 1900 there was certainly little dumping, the products being sold fairly cheaply at home, being often indeed "dumped" internally.

As for comparative average prices, the *iron* bar prices tabulated show the same picture as the rail prices, only more markedly. The prices realised by North-East Coast makers were possibly less than those realised by Westphalian makers until 1900, and thereafter higher. It is quite likely that the same was true with regard to steel bars, but there is not a sufficient volume of evidence.[3] In the girder trade, again, there is too little evidence.

[1] The export average was of course, both for steel and iron bar, and for bars of high as well as common quality. The Antwerp and Westphalian prices were for broadly comparable products. [2] Below, Table X.

[3] While steel bar prices were usually above the prices of common iron bar in Great Britain, they were lower in Germany. From 1909 to 1913 the prices realised for steel bars by a German works have been published: they are much below British quoted prices. The same is true, but less markedly, with regard to joists. Here are the figures (German data from article by J. W. Reichert, *St. u. E.* May 12, 1927 p. 787):

	Joists		Bars	
	British quoted d/d	German realised (one works)	British quoted d/d	German realised (two work
1909	112	106	122	102
1910	121	107	126	105
1911	125	109	127	107
1912	135	110	150	110
1913	140	111	160	113

It is striking that in the most acute home competition of the 'nineties the German home price for girders never fell below 75*s*. per ton, whereas rails were sold in Britain throughout 1895 at an average price of below 70*s*.[1] This suggests that British makers' prime costs were then below German. In the few years just before the war, on the other hand, British quotations were considerably above the German realised price.[2] This is consistent with a parallel trend, but is not proof. In the plate trade there are more ample data, which may be conveniently tabulated.

Table X

Plate Prices, 1885–1913 (shillings per ton)

	German			British	
	Home[3] (quoted) F.O.T. Essen	Export average (all qualities)	Realised[4] at works (one works)	Quoted[5] d/d Clyde	Realised[6] at works (six works)
1885–9	148	—	—	133	—
1890–4	157	179	—	120	—
1895–9	136	139	—	112	—
1900–4	145	126	—	122	—
1905	120	111	—	122	109
1906	140	—	—	140	120
1907	140	—	—	144	133
1908	113	122	—	121	119
1909	108	114	107	116	114
1910	120	120	112	125	115
1911	123	127	115	131	125
1912	123	136	121	148	131
1913	120	133	125	151	143

From these figures it looks as though the German makers were still obtaining a higher average price for plates than the British in the early years of the new century, but that the position changed about 1905–7. In the latest pre-war years the British firms obtained the higher net average price. In the semi-product trade it looks as though the same kind of change

[1] Above, p. 103. [2] Above, p. 110, n. 3.

[3] Grobbleche—heavy plates of ordinary quality.

[4] Published in J. W. Reichert's article just quoted above in the notes.

[5] Ship-plate prices supplied by Steel Company of Scotland to the Board of Trade, and mostly published in *Survey of Wholesale and Retail Prices in* 1903; the later figures communicated. [6] For wage ascertainment. Ordinary plates.

occurred earlier, about 1900; but in this trade there are only quoted prices to use in conjunction with the export averages.

Thus the records give a fairly uniform picture of the price history for a wide range of heavy steel products. Had the dropping of the German average price below the British average after 1900 been limited to a single trade its significance might have been deemed negligible, since it might have depended upon circumstances peculiar to a single trade: in the rail trade, for example, fear of government displeasure at monopoly exactions; in the ship-plate trade, the need of special competitive effort, etc.; and since all firms made several products, what they lost on the rails or plates they might have made up on the girders or bars. This clearly was not the position: for the trend in all the trades studied was similar. But it may be objected that the products of the British and German industries were not strictly comparable; that though changes of cost *are* probably reflected in price changes, the cheaper German product of the nineteen-hundreds was not usually made by the same process as the British product. For most of the products whose prices have been surveyed this was true: the German products were made normally, the British products rarely, from Thomas steel; a growing proportion in Britain was made in the open hearth, most still with non-phosphoric ores. Of the products here considered only plates were normally made of open-hearth steel in Germany.[1] But this in no way affects the bearing on the Tariff Reform analysis of the price and cost trends which have now been studied. For when German products competed successfully with British the German goods were accepted by consumers as of suitable quality; if there was a difference of quality as well as of process the consumers showed that they welcomed the cheaper article even if it involved a sacrifice of quality. As will be seen later, in many instances such a sacrifice was not necessarily involved.

Rigorous analysis of British and German price data would then have established the Reformers' contention that acute tariff-supported price discrimination was neither a novel nor a

[1] For O. H. steel in Germany an extra was paid of 2*s.* to 5*s.* a ton on quoted prices.

spasmodic element in German competition, but for long persistent. At the same time it would have made it seem uncertain, even unlikely, that recent trends were to be explained mainly by this fact. Indeed, the degree of discrimination had recently declined: and its effectiveness was ostensibly a sign that the British industry had become a relatively high-cost industry. How far, assuming equal costs, the industry unaided could have met the German tariff-fed competition with success; how far, that is to say, this competition presented an insuperable obstacle to British makers, could not be told from price data alone. These data suggested that cost disparities were significant, but gave only a vague impression of their scale. They naturally shed no light on the problem whether the disparities were a symptom, not a cause, of competitors' success. To discover all this the cost problem must be attacked directly.

Before doing this it is convenient to glance at the course of prices in the United States, since the fear of American competition was so potent during the Tariff Reform campaign. The following table shows the main trends:

TABLE XI

American Steel Prices

(Averages, in shillings, at Pittsburg)[1]

	Rails	*Rails British (realised)*	Billets (Bessemer)	Steel bars	*Steel Bars (German)*	Tank plates	*Plates British (realised)*	Beam
1890	132	*100*	126	—	—	—	—	—
1895	100	*70*	77	—	—	—	—	—
1898	73	*87*	64	87	*118*	99	—	109
1899	118	*96*	125	168	*130*	201	—	166
1900	135	*130*	105	143	*185*	140	—	175
1902	117	*97*	127	145	*112*	156	—	166
1904	117	*89*	92	122	*108*	140	—	140
1907	117	*126*	122	146	*138*	156	*133*	156
1909	117	*94*	102	122	*102*	130	*114*	130
1911	117	—	90	115	*106*	120	*125*	121
1913	117	—	107	143	*109*	137	*143*	137

[1] The normal transport cost to the coast was over 10*s.* after 1900; favourable export rates can hardly have brought the transport to Britain below 20*s.* a ton.

For comparison some British and German price sèries have been included in the table. The source of the alarms of the early nineteen-hundreds is easily traced in the phenomenal fall of 1898. But this was only a flash in the pan; sales were being made at or below the prime costs of the best plants. The subsequent prices show what extensive discrimination was required to penetrate the British market, and make it fairly evident that American competition could not have the significance of Continental save in regions where it had great geographical advantages.

(Notes on Table VIII)

[1] *Statistik d. deutschen Reichs: Eisenbahnstatistik.* Until 1897 the railway year was from April to March: from 1898 it was the calendar year. (Thus the year 1897 in the table is strictly 1897–8: and overlaps with 1898.) This might make considerable distortion in comparisons, but it is possible to check this, and the distortions are not serious. The allowance for the transport cost of rails which these figures include is hard to assess. In all probability 12*s.* a ton may be safely assumed in guessing the adjustment needed to show real price discrimination: but there are no authoritative figures. The rate from Westphalia to Berlin was 17*s.* a ton; and there were not many places much more distant from one or other of the chief railmaking centres. (Many rates may be found scattered in the *K.V. u. d. Kartelle.*) A post-war official inquiry (*Die Deutsche eisenerzengende Industrie*, 1930, p. 109) gave the average freight rate on steel bar to the chief German towns, not weighted according to their importance as consumers, as 16*s.*; with this in mind the figure adopted in the text seems a reasonable estimate of a pre-war average. A comparison of columns 1 and 2 in the table gives no help. For the export trade an average rate of 4*s.* a ton may be adopted. The rate to the Belgian or Dutch frontier from Westphalia, or to the French or Belgian frontier from Lorraine and the Saar, cannot have been more than 2*s.* or 3*s.*; but there were higher rates to Baltic ports and to the Swiss and Austrian frontiers—the latter ultimately mainly from Lorraine and the Saar. Since German prices were for metric tons they should be raised by 1·5 per cent in order to be strictly comparable with British figures. Hence where the German figure is above the British the absence of this correction tends to an under-statement of the degree of discrimination.

[2] Quoted from Däbritz, *Bochumer Verein*, p. 197. They are substantially the same as those quoted in the Press.

[3] From this point the figures are those given by the Steelworks Union to the Kartell Inquiry, *K.V. u. d. Kartelle*, IV, p. 580. These figures look less congruous than they are with those in the first column because they are averages over a year. The main contracts were no doubt placed early in the year. The price range in 1899 was from 108 to 127; in 1901, 100–120; in 1903, 105–30. Only the figures for 1900 appear irreconcilable.

[4] *Statistik d. deutschen Reichs.*

[5] G. de Leneer, *Les prix de 1890 à 1910 dans l'industrie du fer et de l'acier*, in *Schriften d. Vereins für Sozialpolitik*, CXLIV (1914), pp. 109–10.

[6] de Leneer, *loc. cit.* The *Economist's* prices are similar to those in the trade journals, e.g. in *Engineering*, and *I.C.T.R.*, where they have been compared.

[7] Based on the percentage additions to wages given to the workers at Eston and Barrow. The bases of these sliding scales were published.

[8] From this point the data are less satisfactory: the basis of the Barrow figures seems to have been changed, and the Eston figures give an incomplete picture alone, since when the price of rails was £5 per ton wages rose no more. Moreover at this time Eston was having difficulties in finding a market for Thomas steel rails, and its price may have been below that which other British firms obtained. For 1907 the "average by sliding scales" is above the average value according to the Census of Production, which is 119·3*s.* Here, however, second-grade rails may have been included.

Chapter VIII

THE ECONOMY OF LOW WAGES

American advances, and the report of a delegation of the British Iron Trade Association which visited Belgium and Germany during the spring of 1895,[1] moulded the dominant opinion in the early nineteen-hundreds concerning the influence of English wage rates on the progress of foreign competition. It was commonly known that wages were higher in the United States than in England. And the report of the delegation made it seem doubtful whether English wages were higher than those paid by producers in the most important competing region in Europe.

During the long depression of the early 'nineties the English workman's wages had been freely held responsible, as in the past, for the distresses of ironmaking. The inquiry of 1895 was in conception a courageous effort to test this high-wage theory. Representatives of masters and men went side by side to make a "co-operative investigation of unpalatable facts".[2] Six months after returning they issued their report, which was a broad survey of the comparative advantages of British, German and Belgian works.

Curiously enough, wage disparities were not discussed here in detail; but their influence was "writ small". The delegates did not feel, they reported, that they were "called upon to make detailed comparison". Indeed this could not be done "without a wider range of figures". Wages of different districts varied considerably "even in our own country". So, having collected figures from a few factories, they "were agreed to leave them, as they stand on record, to speak for themselves". They did,

[1] *Economic Conditions of the Iron and Steel Industries of Belgium and Germany*, 1895.

[2] *Econ.* Jan. 25, 1896, p. 101. It was the men's union which first planned a visit of investigation, and the employers' association, hearing of it, suggested a joint trip: *Proc. S. Staffs. Inst.* IX, pp. 103–4.

however, approach nearer than this resolution suggests towards a general conclusion. Belgian wages were admittedly far below British or German, but the labour there was far less effective, and more men—sometimes twice as many—were needed on a job: hence, it was implied, differences in labour cost were negligible. And as for Germany, apart from the chief rollers (the mill contractors in Britain), "there is not the difference in the wages paid as between Germany and this country that is generally supposed to exist, taking into consideration the whole manufacturing departments in iron- and steelworks".[1]

In support of this they presented in an appendix recording their visits to individual plants some figures which were undeniably impressive. In one instance they had been told that not a man of the 560 working in the basic-Bessemer shop had less than 6 Marks a day;[2] in another works the minimum wage at the rolling mills was 6 Marks; in another 5 Marks.[3] It was always the minimum rates which were impressive, not the high figures: very few men had more than 8 or 9 Marks a shift save the chief man in a department, who had from 10 to 15 Marks. But the number of these impressive minimum figures was noticeably small, and the plants where they occurred were new and up-to-date—obviously the "show places" of the time. And scattered among these instances were others which told a different tale. Krupp had many manipulative workers at his mills earning only 4 Marks a shift;[4] there were Westphalian Bessemer shops where shift wages went down to 3·75 Marks,[5] there were stockyards, with enormous labour forces, where wages varied from 3 to 4 Marks,[6] and an important blast-furnace plant with no wage above 4 Marks.[7] Hence, though the figures collected were too few to form the basis of generalisation, they were ample enough to show that the ground was tricky.

Shift rates did not, of course, constitute the whole of the picture. The *Report* pointed out quite rightly that, in both

[1] *Iron and Steel Industries of Belgium and Germany*, p. 23.
[2] *Ibid.* p. 49. [3] *Ibid.* pp. 44, 46.
[4] *Ibid.* p. 35. "Works H": easily identified. Krupp's rail mill was, at this date, rather antiquated.
[5] *Ibid.* p. 43. *Ibid.* p. 47. *Ibid.* p. 40.

Germany and Belgium, steelworkers' hours were no longer than in Britain, mealtimes being in fact longer and more regular;[1] while in both the Continental countries firms had expenses in connexion with their labour in addition to wages. They gave opportunities for the purchase of houses cheaply, and let houses at low rents: some voluntarily helped in the provision of pension funds, and all in Germany were compelled to bear the burden of various State insurances. Factors of this kind all tended to reinforce the conclusion that the Continental makers had little advantage in the price of their labour. On the other hand it was recognised that the Continental labour had some qualities, other than its price, which were an advantage for employers. "The workmen generally discharged their duties as if they were acting under military commands. There was no slovenliness, no undue haste, no noise, no idling about, and the foreman in a quiet and unobtrusive manner, appeared to control everything without commotion. Each man worked as if he were a piece of machinery." Military training, it was suggested, might account for this discipline, which did not depend on dogmatic commands, but co-existed with cordial relations between managers and men. The delegates were impressed with the physique of the men (presumably the Germans) and with their "sobriety and steadiness".[2]

In the tariff campaign of the early nineteen-hundreds the conclusions of this *Report* of 1896 were accepted very generally by politicians, and by economists of different schools—by Ashley, for example, leader of the historical economists and a tariff reformer,[3] and by Marshall, most distinguished of the "pure" economists and a Free Trader.[4] They formed the basis of the evidence given by J. S. Jeans to the Tariff Commission[5] as secretary of the British Iron Trade Association, and superficially they might be regarded as "undoubted authority".[6] But this was conditional on a neglect of criticisms passed on the report at the time of its publication. H. M. Punnett, a Midland

[1] But see below, p. 131, note 3.
[2] *Iron and Steel Industries of Belgium and Germany*, p. 16, *passim*.
[3] W. J. Ashley, *Progress of the German Working Classes*, pp. 10–12.
[4] A. Marshall, *Official Papers*, p. 379.
[5] *Rep. Tariff Comm.* § 1047.
[6] The phrase is S. J. Chapman's, in *Foreign Competition: Work and Wages*, p. 65.

ironmaker, had pointed out that it was a serious weakness that, in discussing German wages, only Westphalian conditions had been observed, since other important districts admittedly had much lower wages.[1] William Jacks, the prominent iron merchant, who as President of the Association had helped to provoke the delegation, showed that the only clue given in the *Report* to the general level of wages in the German industry (a clue given indirectly and perhaps unconsciously) implied an average annual wage of £43, which did not harmonise with the suggestion that 5*s.* and 6*s.* per day were representative wages for a large proportion of German steelworkers. In 1895, he said, British firms paid average earnings varying between £73 and £80.[2] The *Report* was thus shown to be neither self-consistent nor comprehensive. There were more fundamental criticisms directed against the personnel and organisation of the delegation. Statements that the members had just appeared at foreign works without warning and unexpectedly were rebutted with acrimony by Jeans, but Major Patchett, another member of the delegation, leaves no doubt that the firms visited had not been made adequately aware in advance of the object of the tour, and it was not possible at short notice to obtain figures.[3] This was the more important since the delegates in reporting determined only to take account of data which they observed directly; they did not intend to collate material not personally acquired on their tour.[4] It was left for a German newspaper to point out that Jeans alone of the party could speak German at all,[5] and since he was the only delegate not professionally

[1] *Proc. S. Staffs. Inst.* XI, p. 110.

[2] *Report* of address to the British Iron Trade Association, *Engineering*, May 15, 1896, pp. 624–5. The German annual figure is derived from a statement that 10*s.* 8*d.*, the sum paid per head by eight of the chief German iron and steel firms for accident insurance, represented 1·2 per cent of their total wage bill: *Iron and Steel Industries of Belgium and Germany*, p. 18. The figures for England were no doubt confidential figures to the Iron Trade Association: see below, p. 139.

[3] *Engineering*, Sept. 6, 1895, p. 303 and *Proc. S. Staffs. Inst.* XI, p. 104. It is clear of course that witnesses did not see wage records.

[4] *Engineering*, May 15, 1896, pp. 624–5.

[5] The *Cologne Gazette*, quoted in *Engineering*, Sept. 6, 1896. It is helpful in judging the value of the report of 1895 that Jeans did not appear a clearheaded witness under cross-examination, when representing the Iron Trade Association before Royal Commissions and Parliamentary Committees.

engaged in ironmaking, he was naturally the least well equipped to cross-examine informants. Finally it was an open secret that the representatives of masters and men were not at one on many points, and that the *Report* was a compromise after much evidence considered valuable by one side or the other had been suppressed.[1] Probably the employer representatives allowed the general comparison of wages to be stated in a form for which the evidence gave a very slender support on condition that the quality of Continental labour was well praised.[2] In face of the varied comments of contemporaries it is impossible to give the views of these tourist delegates the respect due in the previous decade to the views of Lowthian Bell, which were based on frequent visits and intimate friendships. And a review of other available evidence shows that their views were misleading: that the change they appeared to record had not occurred.

The problem which the *Report* of 1896 dealt with summarily had been studied six years earlier with more care and more detachment by Carroll Wright, the United States Commissioner for Labour, and his work[3] is the appropriate starting-point in a precise elucidation of the position on which the English *Report* was the orthodox but misleading authority in the early nineteen-hundreds. Wright gathered, through a "field force" of specially appointed agents, a formidable mass of information from British and Continental iron and steel firms with a view to comparing the costs of production in the United States and elsewhere. In this work there was no lack of statistics. The *Report* published included detailed statements of the costs for individual firms of materials, transport, labour, etc.—in the successive stages of iron and steelmaking—together with studies of the income and expenditure of a multitude of workers of all grades in the industry. The names of the firms (and for Con-

[1] E.g. *Engineer*, leading article, Jan. 10, 1896, and W. Jacks, *loc. cit.*

[2] The *Report* is probably a better guide on matters of technical efficiency than on wages. There was no cleft of opinion, and it is relatively easy to appreciate the mechanical, though not the economic, qualities of plants in a hasty visit. Cf. below, p. 213.

[3] *Sixth Annual Report of the Commissioner of Labour*, 1890, Washington, 1891 (Executive Document No. 265, 51st Congress, 2nd Session).

tinental firms their nationality as well) were omitted, their place being filled by numerical symbols. Those who appreciate the search for clues may find pleasure in identifying the firms. The material needs careful handling for many reasons, not least because there was no system of costing common to all firms; but probably a large proportion of the figures may be relied on. It is unlikely that the heads of families or the heads of firms would give false information in great detail where it was not incumbent upon them to give any information at all, and where comparison is possible the facts stated usually agree with other available material.

This American evidence presents a picture fulfilling Bell's anticipations in the late 'seventies. Almost the whole of the information on wage rates and incomes shows the Continental level considerably below the English, and frequently the Continental producer is represented as enjoying not only lower wage rates but lower labour costs.

Average hourly rates of wages are given for a number of firms for blast-furnace work, steel melting, merchant bar-iron rolling, and steel-rail rolling. Presumably the firms were in some measure representative, though the readiness to provide data will have influenced the selection. These are the figures:

TABLE XII

Hourly wages in 1888–9

	British	Continental
Iron smelting[1]	2½*d.*, 3*d.*, 3*d.*, 3¾*d.*, 4¼*d.*	2*d.*, 2*d.*, 2*d.*, 2*d.*, 2½*d.*, 2¾*d.*
Merchant-bar rolling[2] ...	5¼*d.*, 5¾*d.*, 7*d.*	3½*d.*
Steel melting,[3] open-hearth	5½*d.*, 10*d.*	2¾*d.*
converter	—	2¾*d.*, 3¼*d.*
Steel-rail manufacture[4] ...	6*d.*	2½*d.*, 2¾*d.*, 3*d.*, 4¾*d.*, 4¾*d.*

It is significant here that in no process save iron smelting was the highest Continental rate above the lowest British rate. But

[1] *Report of U.S. Comm. of Labour*, pp. 321–6, 601. [2] *Ibid.* p. 601.

[3] *Ibid.* p. 610. The very high figure for one British open-hearth shop probably refers to a limited number of highly paid workers only; this feature has been discovered in the records of Bolckow Vaughan's, referred to below.

[4] *Ibid.* p. 610.

there are difficulties in interpreting the figures. In the first place, wages varied much from district to district in Britain and in Germany. Details in Wright's survey show that the low blast-furnace rates in Britain were paid at old installations in Scotland and South Wales, notoriously low-wage districts. It is not possible to tell, however, whether the European figures include any from Westphalia, where Continental wages were highest. The second difficulty arises from the modes of wage payment. In all countries there were many piece workers, particularly in puddling, steel melting and rolling; hence variations in the intensity of work would vary earnings slightly from week to week. More important, it was becoming increasingly common in Great Britain for wages to be linked with prices by the institution of sliding scales; and appreciable changes in the percentage additions to wages might occur every few months.[1] In Europe there were no sliding scales, but wages also moved with prices, though less violently than in Great Britain. For comparative purposes, therefore, the precise date for which wages are given, and the intensity of working, facts which are not forthcoming, are important. For example the rail-making rates were current at a date between January and October 1889, a period during which prices were rising and the percentage addition at one British works[2] rose by ten. Moreover it is likely that the British figure was taken for a good week's run of the mill, above the average.[3]

The deficiencies of these statistics of hourly rates are partially offset by the study of annual incomes which the American *Report* includes, though here again complete comparability of dates is not assured. The incomes studied were those of married men with families; they covered a wide range of occupations, of differing grades of skill; they were clearly meant to be representative, though the samples are too small to ensure it; and both the nationality of the recipients and the country in which

[1] Below, fig. II.

[2] Bolckow Vaughan's.

[3] The mill made 2446 tons a week; in six months the output was 38,000 tons. *Report of U.S. Comm. of Labour*, pp. 164–5 and 594. There are no data to show the position in the Continental mills with high rates.

they worked were given. The summarised results of these studies, together with comparable figures for the United States, were these:

Table XIII

Average Annual Income of Heads of Families in Sample Groups

		Product					
Country	Worker's nationality	Pig iron[1]	Bar iron[2]	Steel[3]	Coal[4]	Coke[5]	Ore[6]
		£	£	£	£	£	£
Great Britain:	English	87	96	90	80	68	
	Irish	81	68	76	84	67	
	Scots	79	101	120	84		
	Welsh	64	—	67	72		
Germany:	German		49	51	54	57	53
	Polish		52	48	—	—	
Belgium	Belgian		44	—	61	41	
United States	Combined	104		120	89	107	70

Figures of this kind should not be pressed far, but the contrast between Continental and British averages cannot wholly mislead, though it may possibly exaggerate. The high English and Scots figures must be written down considerably, since migrant Celts were found in all the expanding ironmaking districts; Irish were very numerous in Scotland, and by that route they came to Cleveland, which in its rapid growth drew also on Wales for labour. Cassidy and Connolly and Murphy, Williams and Thomas and Jones—names such as these were common in the ironworks of the North-East Coast. Although the number of instances on which these averages were based varied greatly, the samples included a big variety of occupations, and none of the high English figures is dominated by a few exceptional

[1] *Ibid.* p. 1169.

[2] *Ibid.* p. 1195. French figures given for bar-iron making yield a surprisingly high average: £69. Belgian workers in France earned, as sampled, £75.

[3] *Ibid.* pp. 1219–20.

[4] *Ibid.* pp. 1233–4. There were Italian workers in English coal mines, earning £42 a year.

[5] *Ibid.* p. 1247.

[6] *Ibid.* p. 1260.

wages.[1] But it is still impossible to tell whether the German figures represent Westphalian conditions, and this must be tested from other sources.

Wright's "direct labour costs" have a more debatable value than his statistics of wages. The problem was more difficult to handle; and the figures collected are greatly diminished in usefulness since they are not coupled with any thorough knowledge of capital costs. Moreover an appreciable labour cost was hidden by Wright in his analysis in an item of cost for "supplies and repairs", which includes all maintenance labour.

TABLE XIV

Direct Labour Costs (per ton)

	British instances	Continental instances
Pig-iron making:[2]		
Bessemer	2*s.* 6*d.*, 2*s.* 6*d.*, 3[illegible] 1*d.*	1*s.* 9*d.*, 1*s.* 10*d.*, 1*s.* 10*d.*
Basic	3*s.* 3*d.*	3*s.* 0*d.*, 3*s.* 2*d.*
Forge	?	1*s.* 10*d.*, 2*s.* 10*d.*
Steel making:[3]		
Melting: Bessemer	[illegible]*d.*, 2*s.* 8*d.*, 3*s.*	1*s.* 10*d.*, 2*s.* 10*d.*, 3*s.* 7*d.*
Thomas		4*s.* 2*d.*, 4*s.* 2*d.*, 4*s.* 3*d.* 4*s.* 4*d.*
Siemens	6*s.* 7*d.*, 7*s.* 1*d.*	4*s.* 1*d.*
Rail making:[4] from ingots	5*s.* 6*d.*–6*s.* 7*d.*, 6*s.* 5*d.*–7*s.* 4*d.*	10*s.* 6*d.*, 10*s.* 9*d.*, 11*s.* 2*d.*, 4*s.* 3*d.*
from blooms	5*s.* 3*d.*–6*s.* 11*d.*, 10*s.* 7*d.*	4*s.* 4*d.*–5*s.* 3*d.*
Plate making from ingots[5]	18*s.* 4*d.*	15*s.* 1*d.*, 13*s.* 9*d.*
Bloom rolling	1*s.* 8*d.*	8*d.*
Plate bar rolling ...	5*s.* 7*d.*	5*s.*
Wire rod rolling ...	—	11*s.* 8*d.*
Light plates (sheets) ...	—	19*s.* 10*d.*, 24*s.* 4*d.*

Thus the figures cannot show the proportionate importance of labour costs in prime costs. Nevertheless these are the most comprehensive published figures, and subject to their limitations

[1] E.g. out of 114 English bar-iron workers, 22 earned less than £63; 41 between £63 and £83; 19 between £83 and £104; 32 over £104. Of 79 Belgian bar-iron workers only 20 earned above £52; of 22 Germans, 4 above £63, none above £72: *Report of U.S. Comm. of Labour*, pp. 820 sqq.

[2] *Ibid.* pp. 35–7, 567.

[3] *Ibid.* pp. 152, 156.

[4] *Ibid.* p. 166.

[5] Data for plates and the remaining products, *ibid.* pp. 183–4, 189–90.

they are probably reliable. In the above table instances of costs in British and Continental plants have been separated, and it is noticeable that for all processes in which comparison is possible there are Continental costs lower than the lowest British cost. This might, of course, be accidental, but it suggests that the high level of wages was not often counterbalanced by the efficiency of the British labour supply and by skilful technique. It is unlikely that the best Continental plants at this date had better labour-saving equipment than the best British plants, and the low Continental figures are scarcely susceptible of an explanation on this basis. It is probable, however, that Continental makers economised material more than British, and in so far as this happened it might reduce labour costs.

Much of the information collected by Wright can be confirmed and amplified from other sources. Statistics of British blast-furnace men's wages, for instance, were collected by the Board of Trade for 1885–6, and others were presented to the Royal Commission on Labour a few years later: they substantiate fully the figures given in the American *Report* and the regional differences which can be traced therein.[1] Other evidence collected for the same Royal Commission from Belgian official sources, gave support to Wright's low estimate of Belgian wages.[2]

The Blue Books of these years are virtually silent about British steelworkers' wages. But a study of Bolckow Vaughan's contemporary records for the Cleveland Steelworks suggests the

[1] The *Report on Wages in* 1886 (1891) showed that when the numbers employed by the firms giving evidence for 1885 were at their maximum (7209), the average weekly wage was 27*s*. 3*d*.; when at their lowest (6105), it was 25*s*. 4*d*. For 1886 the average was only 24*s*., but for Cleveland it was 25*s*. 7*d*., for Wales 17*s*. 6*d*. By 1888–9 Cleveland wages had risen with prices. For details of basis wages for most North-East Coast furnaces see *R.C. on Labour*, Digest of evidence, Section A, Qs. 14,245 sqq.

[2] *Ibid*. Foreign Reports, Belgium, p. 30. In 1891, a year of higher wages than those prevailing when the American material was collected, Belgian blast-furnace workers averaged 2*s*. 3*d*. per shift, the Cleveland average being over 4*s*. The Belgian steelworkers' average was 2*s*. 10*d*., the malleable ironworkers' rather less. Also *First Abstract of Foreign Labour Statistics*, 1899, p. 25, giving details for Seraing which show only one grade of blast-furnace men and two grades of steelworkers earning above 4*s*. a shift in 1891.

accuracy of Wright's survey for this group of workers also, and very greatly supplements it.[1] The most valuable information in these records is an elaborate analysis of the earnings per shift of a very large number of piece workers in the years 1888–91; and this, together with statements of the datal wages of the other workers, and the numbers employed, allows a close estimate to be made of the average earnings of most of the "manufacturing" staff. Here are the summarised results for 1888:

TABLE XV

Shop	Number of workers: On piece	Number of workers: On time	Output per shift (tons)	Wages per shift*: Tonnage	Wages per shift*: Datal	Average
Bessemer	77	83	256	6s. 1d.	3s. 4d.	4s. 8d.
Thomas	171	120	286	6s. 8d.	3s. 3½d.	4s. 11½d.
Mills	192	246	Rails 270	7s. 4d.	3s. 2d.	5s. 0½d.
			Plates 40			
			Fish 15			

* The data appear to have been based upon a sample of about sixty shifts.

Curiously, the mill figures do not include the rolling gangs of the plate and rail mills, which may well be thought the kernel of the shops.[2] The earnings of these men can be accurately calculated since the gang rates are known and they would bring the average wage of the mills and converter shops together above 5s. per shift. For two important "manufacturing" groups no information is given: for the open-hearth melting shop, and for the "rail bank" men—who drilled and filed and otherwise "dressed" the rails after they had been rolled and straightened. It may be assumed from records of 1891, 1893 and 1895 that these wages, were they accurately known, would not lower the "manufacturers'" average.[3]

[1] I am very greatly indebted to Messrs Dorman Long and Company for allowing me to consult these records.

[2] There were 60 per shift, and their earnings averaged 6s. 8d. per shift.

[3] For Oct. 1895 rail-bank labour averaged 5s. 3d. per shift. Prices were lower, and wages had no percentage addition above the steelworks scale in 1895: they had 3½ per cent in 1888. But perhaps tonnage was higher in the later year. According to records for 1888 the rail-bank labourers numbered 200. For 1891 open-hearth steelmelters and teemers averaged about 10s. a shift.

Between 1888 and 1891 wages rose with prices. The movement of the datal wages was governed by the sliding scale, which gave an average, in 1890, 20 per cent above the level of 1888.[1] The average shift wage of tonnage workers in the mills in 1889 was almost 5 per cent above the figure of 1888, and 20 per cent above it a year later. In the converter shops tonnage wages rose less.[2] For the "manufacturing" workers as a group the shift average rose to 5*s.* 9*d.* or more in 1890.

None of the information here is directly comparable with any of Wright's figures, but a suggestive parallel may be drawn between his average of 6*d.* per hour for English rail rolling at some date unspecified in the first half of 1889, and the "manufacturers" average per shift in the mills at Bolckow's during the whole of 1889, which was approximately 5*s.* 6*d.*[3] Since Wright's figure was probably for a good run on the mill in question, it is perfectly compatible with the rather lower annual average of the Eston mills.[4]

In international comparisons it is often more important to know the average shift wage for all the staff of a steelworks than the figure for those who were engaged in "direct manufacturing labour". Bolckow Vaughan's records do not present such complete or well-assembled information for the more general figure as for the "direct labour" figure. The statistics hitherto quoted were drawn up in connexion with negotiations over the sliding scale at Eston. Only four-fifths of the staff were affected by this scale, and even for these the information collected was incomplete.[5] There is, however, a lot of scattered

[1] Graph II, below.

[2] In 1890 tonnage wages in the acid shop were up by 5 per cent: in the basic shop by 8 per cent; that they rose less than mill wages may have been due both to differences in the number of shifts worked in the various departments and to a greater use of open-hearth steel. The converter made progressively less per shift till 1890.

[3] There is no complete information; this figure takes account both of the workers in Table XII and of the rolling gangs.

[4] It is possible, moreover, that Wright thought of the nominal 12-hour shift as an actual 10½-hour shift and calculated his wage per hour on this basis; the Board of Trade in 1906 took this line in estimating working hours.

[5] Of the four-fifths many were paid indirectly by contractors, and the firm did not keep records of their pay. Below, p. 142, n. 2.

information available for the early 'nineties which allows an estimate of the shift wages of the non-manufacturers to be made.[1] The majority of these workers were mechanical engineers; they worked fewer hours than the steelworkers, numbered about 500,[2] and averaged about 4*s.* 3*d.* per shift both in July 1891 and in December 1893. Steel foundrymen had a slightly higher, foremen a very much higher, average;[3] and, although there were other groups,[4] some less well paid, they were numerically small, and the average shift wage for the whole of the non-manufacturing contingent cannot have been as low as 4*s.* either in 1891 or 1893. Presuming no great recent change had occurred in these wages, the average shift wage for all workers in the Eston Steelworks in 1888 was approximately 4*s.* 8*d.*, rising to 5*s.* in 1890.[5]

It is not known how far the Cleveland Steelworks' figures may be regarded as representative for Cleveland as a whole, let alone Great Britain, at this date. "The Steelworks do not like other employers to know their business", was the comment of Trow (the ironworkers' leader) to the Royal Commission on Labour in 1892, explaining why the Board of Conciliation and Arbitration of the Manufactured Iron and Steel Trades in Cleveland did not, in fact, cover steel.[6] But the secrecy was no doubt concerned with prices or with methods rather than wages. It is likely that when the scales of individual firms were established in 1887, 1888 and 1889, the men at least had comparative

[1] Most of it is in the Letter Books of the Company.

[2] In 1891 the number was 541; in Dec. 1893, 437. At the Consett works in 1896 the number was 371 (*Report on Changes in Wages in* 1896, p. 411): Consett had no converter shops, and the numbers seem reasonably congruent.

[3] Foundrymen numbered 40 and averaged 4*s.* 4*d.*, foremen numbered 55 in Dec. 1893 and averaged 10*s.*; in July 1891 the figures were 71 and 15*s.*

[4] E.g. Signalmen, platelayers, rolleymen, horse drivers, "tacklemen" for steel-structure erection, electricians, etc.

[5] For the 1890 figure no increase in the non-manufacturers' wages has been assumed: but in fact some increase would have occurred, and 5*s.* 1*d.* is a more probable figure. Details for a week in March 1891, when the percentage addition was slightly lower than in 1890, give an average wage for the whole staff (2171) of 27*s.* 8*d.* per week, equal to just over 5*s.* per shift if six days and five nights were worked.

[6] *R.C. on Labour*, Evidence (Group A), Q. 15, 288.

knowledge to help them in bargaining. Through the 'nineties there is evidence of attempts to equalise rates. For instance, in 1895, Bolckow's adjusted their steelmelters' wages "down to the district level"[1]; and in an arbitration award of 1892 the rolling rate at the Cleveland rail mill was fixed both for the present state of the mill and for the time when "Messrs Bolckow Vaughan and Co. Ltd. put live rollers to one of their finishing mills so as to give facilities equal to those at the North Eastern Steel Company's Works"[2]. This arbitration was carried out by Jeremiah Head and Edward Trow, both in touch with local conditions, and the umpire was David Dale, Chairman of the Consett Works, and also a director of the Barrow Steelworks. One would expect through influences such as these a considerable measure of uniformity in Cleveland in the late 'nineties, and since there was little change in Bolckow's basic rates in the decade, it is tempting to assume considerable uniformity in the earlier years. There is evidence of a comparison of Cleveland rolling rates with Barrow's in 1893, but not enough to justify any conclusion concerning national uniformity[3]; wages of melters in open-hearth shops were certainly negotiated on a national basis to some extent throughout the 'nineties[4]. Scattered wage statistics suggest that wages in Scotland, the North-East Coast and in Cumberland were fairly close together, but there is some evidence that Welsh wages were rather lower at the opening of the 'nineties.[5]

It remains to check Carroll Wright's figures against records indisputably Westphalian before the picture of relative wages

[1] From the firm's records.

[2] The phrase occurs in the findings of the arbitrators.

[3] Bolckow's were paying a higher rate, but their plant may have involved more work.

[4] From the early 'nineties there was a national scale for melters in acid shops, and from 1895 there was one for basic shops.

[5] E.g. rates are quoted for some Consett workers which are similar to Bolckow's rates for similar work, in *Report on Changes in Wages in* 1895, p. 155. Rates quoted for Scots mills in *R.C. on Labour*, Evidence (Group A), App. xxxi, are at least as high as Bolckow's. There are records of some very sharp rises in South Wales in the 'nineties, e.g. the average wage for heaters at Ebbw Vale rose from 4*s.* 1*d.* to 5*s.* 9*d.* in Oct. 1893; the final figure was not high compared with Bolckow's: *Report on Changes on Wages in* 1893, p. 67.

around 1890 can be completed. For this purpose there are two useful guides. Krupp's published the average wage per shift paid at Essen;[1] and the employers' association which was constituted to administer the State Accident Insurance published statistics of average annual wages.[2] Both were in some respects defective. Krupp's suffers in two ways. First, the firm was occupied largely in making high-grade steel products, which not only employed some different types of steelworkers from those employed in the making of common grades of steel,[3] but often involved much refined engineering work. Until the opening of the Rheinhausen plant, however, a lot of common steel, particularly rails, was made at Essen. In the second place the wages paid by Krupp had the reputation of being high even for the North-West, and the workmen's leaders asserted that the averages were also inflated by the counting of overtime in normal shift wages. In spite of these deficiencies the Essen figures are valuable because they form a continuous series, calculated on a uniform basis, over a long spell of years. Checked against information for short periods concerning works more completely occupied in the same mass-production steel trade, the figures prove reliable.[4] The fault of the insurance statistics is that until 1900 only wages up to £60 were included fully in the calculations, wages above £60 being docked of two-thirds of their excess over this limit. While the average was well below £60 this might not be seriously distorting, but this stage was passed by 1890. The distortion was always deflationary, and in the absence of other data incalculable.[5] Despite their drawbacks these are both clearly reliable. The first gives an average wage

[1] *Fourth Abstract of Foreign Labour Statistics*, p. 65.

[2] The series up to 1904 is published in *Kont. V. u. d. Kartelle*, IV, p. 593.

[3] E.g. crucible-steel melters, and steam-hammer and hydraulic-forge men.

[4] Several instances are given below in the notes.

[5] From information concerning the distribution of wages at Hörde contained in H. Ehrenberg, *Die Eisenhüttentechnik und der Deutsche Hüttenarbeiter* (1906), it is possible to show that when the mill wages at the works in 1895 averaged £64. 3*s.* the insurance average would have been £58. 15*s.*; but that in 1904, when wages up to £75 were counted fully for insurance purposes, the real and insurance averages diverged by £1 per year for blast-furnace workers, £3 for the Thomas melting shop, £2. 10*s.* and £4. 15*s.* in two mills. These figures are subject to a maximum error of 10*s.* either way.

of 3*s*. 8*d*. per shift in 1888 and 3*s*. 10½*d*. in 1890;[1] the second an annual average of £50. 14*s*. in 1888 and £54. 16*s*. in 1890.[2] These are certainly close enough to Carroll Wright's family incomes to imply (what was in any case likely) that his figures were representative of the chief centre of the German industry.[3]

These crude averages are not, however, rightly to be compared directly with Bolckow Vaughan's average. For the delegates of 1895 correctly said that Continental firms had outgoings for social services which English firms escaped. How much did these amount to? Continental welfare expenditure took two forms. Some of it was in the form of recurrent contributions, proportional to wage payments, for insurance funds of various kinds, official and otherwise. These involved an addition in current labour costs of production. Another part of the expenditure took the form of large occasional contributions for establishing institutions such as co-operative stores or garden cities or child-welfare clinics or "casinos" or schools of

[1] The records referred to above give 3*s*. 7*d*. for 1885, 3*s*. 10½*d*. for 1890; 3*s*. 8*d*. is arrived at by interpolation using other material as a guide.

[2] The following data tend to confirm these figures. At the Phoenix Works there was a rise from £49. 17*s*. in 1887–8 to £65. 3*s*. in 1889–90. This may have been due to an increase in the number of shifts worked, but the very high second figure is surprising. But for the jump it might be explained by a curious system whereby Westphalian firms often included the low wages of learners and young workers in "General Costs" (Otto Jeidels, *Die Methoden der Arbeiterentlöhnung in der rheinisch-westfälischen Eisenindustrie*, p. 269). There is a series of figures for the Rheinische Steelworks in the 'nineties which gives a shift average of 3*s*. 6*d*. for 1893–4, the first year given, when the Phoenix yearly figure was £60. 12*s*. (for probably below 300 shifts). The *Gemeinfässliche Darstellung* of the Verein d. Eisenhüttenleute in 1897 published on p. 106 some figures showing wage levels in 1892–3. Two works on the Rhine averaged £58. 12*s*. and £55; a Westphalian one £51; a Saar works and one in the Aachen district £52. 10*s*. Wright's figure may have been partly for 1889 as well as for 1888. But it did not include any young workers' wages, as Krupp's presumably did. The proportion of young workers in Westphalia was small. See below, p. 146. Krupp's annual figure would be £51 if only 280 shifts were averaged.

[3] In order to accommodate Wright's figure of 4½*d*. an hour for rail rolling to these wages one must assume either that the conditions were wholly exceptional or —what is more likely—that a shift was taken to last 10 hours, with 2 hours' pause for meals. Pauses were more commonly and definitely set aside in Germany than in England, though it was alleged by the men at Dortmund that during times of high pressure there were often scarcely any intervals at all: *Report of Inquiry by Board of Trade into Working Class Rents...and Wages in the Principal Industrial Towns of Germany*, 1908, CVIII, pp. 178–9.

cookery and needlework.[1] This was not an addition to current labour costs: it was a result of good profits, sometimes it was an investment to retain a labour force, and often it may have been a well-judged means of avoiding a rise in wages; it certainly often coincided with bounding trade. Such expenditure, then, though often imaginative and socially important, may be neglected in a study of wages with reference to labour costs. The extent of the recurrent type of expenditure, which may not be neglected, can be judged from the records of some of the large firms. Krupp's expenditure on sick-benefit funds from 1885 onwards amounted to 1·5 per cent on wages; for pension funds 0·5 per cent. The normal expenditure of firms on accident insurance was 1·2 per cent. Krupp's total would therefore amount to rather over 3 per cent—about 1½*d.* per shift in the years 1888–90.[2] The expenditure of a great coal concern, the Gelsenkirchen Company, was rather higher—6 per cent in 1888.[3] But even this for a steelworks paying a shift wage of 3*s.* 9*d.* would not have brought the total expenditure to 4*s.*

Here then is a figure representative of Westphalian conditions, which, when compared with those estimates for Bolckow Vaughan's which may represent the situation in the chief British exporting centres save South Wales, gives a more precise view than can be had from Wright of the difference between the British steelworkers' wages and those of the highest-paid Continental group. Expressed in tabular form this is the contrast, together with the Belgian figure for 1890:

TABLE XVI

	1888	1890
Average shift wage at Bolckow Vaughan's	4*s.* 8*d.*	5*s.*
Average shift wage at Krupp's, plus 6 per cent	3*s.* 11*d.*	4*s.* 1½*d.*
Average shift wage of Belgian steelworkers[4]		2*s.* 9*d.*

[1] It might take the form of house building, which occurred freely in England. The English Truck Acts checked "store" developments. The casinos are virtually club accommodation for the officials; they sometimes include sleeping accommodation for visitors, inspecting engineers, or prospective buyers.

[2] *Krupp*, 1812–1912, pp. 205–12.

[3] The figures come from a *Festschrift*, privately printed in 1912.

[4] No allowance for welfare services.

The relative position indicated here did not greatly change in the next fifteen years. The gap between British and Westphalian wages in years of moderate activity—it is quite impracticable to speak of an average gap—was little if at all smaller in the early nineteen-hundreds than in the late 'eighties, though proportionately its importance diminished with the rise in the level of wage rates.

The movement of Westphalian wages may be traced from year to year satisfactorily in Krupp's series, which is illustrated, together with the Insurance series, in Fig. II.[1] Allowing for social service expenditures the Essen daily average for 1904, the year of the Tariff Commission Report on Iron, was 5*s.* 1*d.*: the average income for the whole year, uncorrected for social services, was £67.[2] This figure was lower than the Insurance average (£68. 13*s.*), which suggests that the Krupp figure was low rather than high for the district; because the Insurance average was certainly below the real average of iron and steelworkers, and blast-furnace workers' weekly wages were a little lower than steelworkers' (which figured alone in the Krupp figures).[3] But the discrepancy may have been due to the working of rather fewer shifts in Krupp's than in the majority of works.[4] The Essen figure harmonises closely with detailed statistics from Hörde,[5] and is much above that given by the Gainsborough Commission, a group of British artisan engineers anxious to find the best they could in Germany, for the famous Bochum works.[6] For comparative purposes, as will be seen

[1] The graphs have been inserted at the close of the book.

[2] *Gainsborough Commission Report*, p. 21.

[3] Since iron smelters worked 7 shifts a week, steelworkers 5½–6 shifts, the composite annual average does not necessarily allow any reduction regarding shift wages. But since blast-furnace men's wages for 7 shifts were almost as much as steelworkers' for 5½ the annual figure may be used to obtain a steelworker's shift figure, assuming a year of 280–300 shifts. Hörde blast-furnace wages were £66. 2*s.* in 1904; steelworks wages £67. 12*s.*: Ehrenberg, *op. cit.* calculated from pp. 165–73.

[4] The Krupp yearly figure represents 279 shifts. I know of no information for the industry as a whole. For 1890–1 Krupp's figures suggest an average of 311 shifts.

[5] Above, note 3.

[6] 4*s.* 4*d.* per shift: *Gainsborough Commission Report*, p. 25.

later, the Essen corrected average for 1906 (5*s.* 7*d.*) is important; it was considerably in excess of a German trade-union estimate of the same date.[1]

There is no information which shows the movement of British wages from year to year as the Essen and Insurance averages do for Westphalia. The percentage additions (based on sliding scales), whose movement is indicated by the representative examples plotted in Fig. II,[2] show impressively the violent short-period fluctuations, often varying much from plant to plant, which distinguished British from Continental wages. But they understate the long-period upward trend of wages, both because there were changes in the basis rates on which the percentage additions were paid, and because the introduction of new equipment tended in several ways to raise wages. Both these processes are obscure, but almost certainly important. There was, for instance, an arbitration at Bolckow Vaughan's in 1892, as a result of which the basis rates of low-paid workers, particularly of workers on datal wages, were raised.[3] Evidence of this sort of change, often affecting few men, is found frequently in the *Annual Reports on Changes of Wages* published by the Board of Trade from 1894. The most direct way in which the introduction of new plant tended to raise the average level of wages was by elimination of low-paid unskilled manual work (a more common occurrence than the elimination of higher grades of labour).[4] Of equal, perhaps greater, importance in

[1] The trade-union average for a considerable number of workers, mainly in Westphalia, was for the summer of 1907, and came to 4*s.* 10*d.* It may have included blast-furnace workers, and if the mixture was representative—say one blast-furnace worker in five—the steelworkers' average would be about 5*s.* 1*d.*, uncorrected for social services. The Union gave an annual figure (£68) which was based on a misuse of the information available, and was demonstrably too low. The correct figure was almost £71. 15*s.*: *Reichs Arbeitsblatt*, 1909, p. 927.

[2] At the close of the book.

[3] The change has been traced in the *Arbitrators' Report.* The lowest level for labourers in the Basic and Bessemer shops was raised to 3*s.* 6*d.*: hitherto it had been nearer 3*s.* Bolckow's records show that in the earlier scale there were 73 workers on a 3*s.* basis in the Basic shop; 15 at 3*s.* 2*d.* or 3*s.* 3*d.*; 7 at 3*s.* 5*d.*; the next grade of datal worker was at 4*s.*

[4] When "soaking pits" replaced the old heating furnaces at Eston in 1893, for instance, 40 low-paid tonnage men were displaced; they had averaged 4*s.* 2*d.* per

raising wages was the tendency for piece rates on new plant of increased capacity to be fixed at rates which were more remunerative than those for older plant. This result was not usually aimed at by employers, but during the time when a new rate was being fixed there was an overwhelming inducement to the men to go slow. Trow recognised this in his evidence to the Labour Commission. After new rates were fixed, he remarked, "The men would continue to improve".[1] He was thinking of rolling-mill experience, but the same thing happened in other departments,[2] and in Germany.[3] It was, of course, manifestly unwise for an employer to alter a new rate in a way that completely nullified for the worker the advantage of speeding up.[4]

It is then impossible to represent the movement of British wages graphically in the fifteen years after 1890. But some extremely valuable information of a more comprehensive character than any hitherto available was collected at the close of this period by the Board of Trade, and published in 1911 after a lapse of time sufficient to render the knowledge innocuous. A survey of blast-furnace men's wages such as had been made in 1886 was repeated, with some of the useful differentiation of districts omitted, and in addition there was a study of earnings in malleable iron and steelworks. The most detailed figures[5] collected referred to a single week in September 1906, but a supplementary survey of the wage bills and numbers of employees at a large number of works in the last week of each month of 1906 showed that the sample week was representative. For the

shift, well below the average wage for all piece workers of 7*s.* 4*d.* There are no details of datal workers (if any) displaced; nor is the number of workers for the new plant known, but certainly it must have been well below 40.

[1] *R.C. on Labour*, Evidence (Sect. A), Qs. 15,194 sqq.

[2] When the first Talbot furnace was set up at Frodingham, for example, after an eleven months' trial, its output was 570 tons a week, and a piece rate was based on this figure; but within a short time the output was 650 tons. From information prepared for an arbitration at Cargo Fleet in 1907, but unpublished.

[3] Otto Jeidels, *op. cit.* p. 112.

[4] As Jeidels put it, if workmen became aware that a piece rate was a disguised time rate it lost its effectiveness.

[5] Not so detailed, naturally, as those for the Cleveland steelworks.

purpose of international comparison the most valuable results arrived at were these:

TABLE XVII

Wages in September 1906[1]

	Total no. of workers	Average weekly wage	No. of full-time workers	Average weekly wage	Average no. of shifts per week	Average wage per shift
Pig-iron production	13,995	32s. 3d.	10,353	33s. 4d.	7	4s. 9d.
Manufactured iron and steelworks	53,981	33s.	34,355	36s.	5½	6s. 6d.

The inquiries obviously covered a large part of the industries concerned, and the averages are for all types of labour employed —manufacturing, power supply, maintenance, loading, etc. In addition to the general averages there were also district averages. For pig iron the districts were Cleveland, Cumberland and North Lancashire, and the Rest of the United Kingdom; for manufactured iron and steel Cumberland and North Lancashire were submerged in the Rest, and Scotland and West Yorkshire were isolated. The North-West led the pig-iron averages, with Cleveland second, a little above the general average. In iron and steel Scotland led; Cleveland was a little below the average; the rest of Yorkshire much below.[2]

For the purpose of calculating average wages per shift, only the weekly wages of full-time workers are certainly reliable, since it is not clear whether the short-time workers worked part of every shift or no, but it is likely they did not. There were extraordinary differences between the wages of full-time and short-time workers in the manufacturing departments, differences which the Board of Trade's presentation is inclined to mask. Among Cleveland steelmelters and Bessemer men and

[1] *Report of Board of Trade Enquiry into Earnings and Hours of Labour in the Metal Industries, Engineering and Shipbuilding Industries in* 1906, *P.P.* 1911, LXXVIII, pp. xvii, xxi. The supplementary studies gave an average wage of 33s. 4d. for all persons in manufactured iron and steelworks, a little above the corresponding figure in the table.

[2] *Ibid. loc. cit.*

rollers the short-time workers, who were very numerous, earned only 50 or 60 per cent of the earnings of full-time men. Here are the figures:

TABLE XVIII[1]

		Full time	Short time
PIECE.	Open-hearth	191 at 71*s*. 2*d*.	111 at 45*s*. 4*d*.
	Bessemer	204 at 49*s*. 1*d*.	62 at 25*s*. 8*d*.
	Rolling	1311 at 54*s*. 6*d*.	190 at 29*s*. 6*d*.
		1706 at 55*s*. 9½*d*.	363 at 38*s* 2*d*.
TIME.	Open-hearth	205 at 34*s*. 11*d*.	99 at 21*s*.
	Bessemer	144 at 28*s*. 2*d*.	199 at 15*s*.
	Rolling	1066 at 29*s*.	645 at 32*s*.
		1415 at 29*s*. 9½*d*.	943 at 22*s*. 3*d*.

Here differences suggest that shifts were often missed. This might be due to irregularity in the working of the plant, to a sharing of work when a plant was only partially worked, to a dependence on casual labour, or to extensive absenteeism, often complained of, and attributed by the masters to intemperance and by the men to the rigours of a twelve-hours' day.[2] The absence of a regular man for one shift in a week, if he were replaced by a "by-turn" man, would mean in the Board of Trade statistics two short-time workers with an average weekly wage equal to half the normal pay for the class of work affected. It was quite possible for a by-turn man to have work in different parts of the same plant on different days in one week, and to appear statistically as two or three short-time workers.[3] The outgoings for the firm for the week would, of course, be unaffected. The average weekly wage for "all workers" is thus only useful in fixing an impossibly low limit which the average shift wage comparable with Continental figures[4] could not possibly reach. The average shift wage for British malleable iron and steelworkers could not have been as low as 6*s*. in 1906; it was probably closer to 6*s*. 6*d*.

[1] The *Report* gives figures for *full-time* workers and for *all* workers.

[2] J. W. Hall in *Proc. S. Staffs. Inst.* IX, p. 103; and *R.C. on Labour*, Evidence (Group A), Qs. 14,163, 14,248 sqq.

[3] *Report on Earnings and Hours of Labour in* 1906, p. xv.

[4] Continental shift wages were not all calculated on a uniform basis, but they *were* based on shift earnings and the number of workers per shift, not on weekly figures converted.

It is important for the analysis of the problems of competition that the regional distribution of steelworkers' wages in the Wage Census shows the lowest wages to have prevailed in the inland Yorkshire districts—in Sheffield, Rotherham, Leeds, etc. These were districts unlikely to be important participants in the export trade in cheap steel, though in some measure they encountered the competition of Continental imports. That the Cleveland figure was slightly below the British average may be misleading, since the big open-hearth shops of the district were inadequately represented in the figures collected by the Board of Trade. Open-hearth shop wages in Britain were far higher than Bessemer shop wages at this time, perhaps largely because the installations were more modern. It seems a fair assumption then that the wages in the chief British coastal exporting districts either equalled or exceeded the average figure of the 1906 *Report* for Britain as a whole.[1]

When the Tariff Commission reported in 1904, with Jeans still adhering to the views of 1895, wages were lower than at the date of the 1906 survey. Extensive records collected by the Board of Trade suggest that the average weekly wage of 1904 for manufactured ironworkers and steelworkers was about 1*s*. 6*d*. below the level of October 1906—about 3*d*. per shift.[2] On this basis the average British steelworkers' wage in 1904 was above 5*s*. 9*d*., and possibly as high as 6*s*. 3*d*.; the Scots minimum was 6*s*. 3*d*. By the same method the minimum possible average for British wages in 1900 was above 7*s*.

If the evidence be interpreted in a way likely to minimise the

[1] It may be further noted that the average for steelworkers alone would have been above that for manufactured ironworkers and steelworkers. Wages in puddling shops were below the average for all other departments of iron and steelworks. Wages of iron- and steel-rollers were not—and could not be—distinguished, but the situation is not very obscure. Possibly the steelworkers' average figure was 2*d*. above the composite average.

[2] An annual *Report on Changes in the Rates of Wages* was published from 1893 onwards, giving both the amount of change in weekly wages and the numbers of workers affected in a large number of trades. The figures for the iron and steel industry after 1900 covered a big proportion of the trade, and it seems reasonable to form an impression of the general change in the industry by assuming that the records are for a constant number of workpeople. Prior to 1900 the records are on a narrower basis, and deduction would be misleading for the period 1895–1900.

gap between Westphalian and British wages, the comparative position for the opening of the new century may be expressed in the following table, in which for convenience of reference the table for the years 1888 and 1890 is incorporated:

TABLE XIX

Average Shift Wages

		1890	1900	1904	1906
British	4*s.* 8*d.*	5*s.*	7*s.* 3*d.*	6*s.*	6*s.* 3*d.*
Westphalian (corrected)	3*s.* 11*d.*	4*s.* 1½*d.*	5*s.*	5*s.* 1*d.*	*d.*

It may be wondered whether at the time of the Delegation of 1895 the incidence of the years of depression had produced a marked but short-lived change in this situation. There is no evidence of this, and there are records of Bolckow Vaughan's wages for October 1895, less detailed but at several points comparable with those for the earlier years, which indicate the reverse. These figures were collected for the use of the British Iron Trade Association, and they were doubtless among those to which Jack referred in criticising the *Report* of 1896. Where the workers were grouped similarly in 1895 and 1888, the average wage was usually higher in the later year.[1] The figures suggest, though they are not full enough to prove, an average shift wage of 5*s.* for the works.[2] In addition to the information on shift wages Bolckow's gave the average annual income at the works as £78. 1*s.* 8*d.* The firm was in no position to draw up an average of the actual yearly earnings of the individuals it employed, since a large number were employed indirectly and their identity did not enter the wage books. The figure is difficult

[1] Basic shop tonnage wages were down to 5*s.* 10*d.* from 6*s.* 8*d.*, an index of slack business; the acid Bessemer tonnage wage had risen from 6*s.* 1*d.* to 7*s.* 9*d.* Heaters and shearers at the plate mills did better than in 1888, and the rail mill and plate mill rollers, estimated to average 6*s.* 8*d.* in 1888, averaged 9*s.* 9*d.* and 7*s.* 9*d.* in 1895. Merchant mill rollers averaged 10*s.* 10*d.* Basic and Bessemer "datal" wages, for instance, averaged 3*s.* 6*d.* in 1895 as against 3*s.* 3*d.* in 1888; for the mills the figures were 3*s.* 8*d.* and 3*s.* 2*d.*

[2] In 1895 there was not, as in 1888, a percentage addition to the basic scale; the rise since 1888 is the result partly of higher basis wages, some through the arbitration of 1892, partly of higher output.

to interpret, but it may very well be the total for a year of the average shift wages for each day, irrespective of the variation in numbers from shift to shift, and on this basis it might support the estimate of 5*s*.[1] This was far above the Krupp and Insurance averages and also well above other higher isolated Westphalian figures.[2]

While there is no indication of a levelling of British and Westphalian wage rates in the middle 'nineties, the criticism of the delegates of 1895 for neglecting the low-wage areas was valid, for these areas were growing rapidly in importance through the 'nineties. When the Stahlwerksverband was formed in 1905, makers in Lorraine, Luxemburg and the Saar had a combined quota equal to 60 per cent of the Westphalian quota; the Silesian makers had a quota equal to 12 per cent of the Westphalian.[3] The development in the 'nineties is shown more fully later.[4] Wages in these districts were astonishingly lower than in Westphalia; the crude average coming between 3*s*. 6*d*. and 4*s*. per shift in the early nineteen-hundreds.[5] These were also the levels of wages in the non-German parts of the minette steel industry—in Belgium and East France—which were growing increasingly important as competitors in steel.

[1] The works, if occupied in at least one department for 5½ days (i.e. six day shifts, five night shifts) every week, would register 313 daily averages, though the real number of shifts per "manufacturer" would be at most 286. 313 shifts at 5*s*. would give a yearly figure of £78. 5*s*.

[2] Hörde mill wages, available in great detail in Ehrenberg, *op. cit.* pp. 171–3, were £64. 3*s*. in 1895: this is to be compared with a "manufacturer's" average at Eston. The Phoenix Works figure of £68 for 1895–6 is so high as to be suspect (above, p. 131, n. 2). It may not be compared directly with Bolckow's annual figure, which was for a date prior to Oct. 1895; from Nov. 1895 the Eston "percentage" rose, being over 5 from March 1896. This does not of course justify the estimating of an annual figure. The Phoenix figure fell to £64 at the close of the 'nineties, but there had been two changes—amalgamation with the biggest Westphalian pure rolling mill, and the purchase of a minette mine. The Rheinische Steelworks gave its average shift wage as 3*s*. 7*d*. for 1895–6 (R. Martin, *loc. cit.*).

[3] Jutzi, *D. Montanindustrie auf dem Wege zum Trust*, p. 32.

[4] In the next chapter.

[5] At Burbach, for instance, out of 3100 workers in 1900, 25·4 per cent had below 3*s*. a day, 36 per cent between 3*s*. and 4*s*., 30 per cent between 4*s*. and 5*s*.: O. Bosselmann, *Entlöhnungsmethoden in der sudwest-deutsh-Luxemburgische Eisenindustrie* (1906), pp. 136–40. In Silesia the figures were probably lower still: B. Simmersbach, *Entlöhnungsmethoden i. d. Eisenindustrie Schlesiens* (1906), p. 49.

The impression given by the report of the delegates of 1895 that average rates of wages in Germany and Britain were very similar cannot then be sustained. But their emphasis on the relative equality in the distribution of wages in Germany, and their suggestion that it was only a few very highly-paid workers in Britain who earned more than their German opposite numbers, deserve further examination: for if there were such a contrast as they suggested it might have a bearing on the relative efficiency of the labour supplies.

The survey of 1906 allows a study of the distribution of British wages to be made, which, while it confirms the view that the wages varied widely, shows that the percentage of workers who earned relatively good wages making malleable iron and steel was high. In Table XX the distribution of earnings of all workers of twenty years of age or above is shown for 1906, together with similar information for the Hörde steelworkers and millmen in 1904.

Table XX

Distribution of wages

(Percentages)

	Under 20*s.*	20*s.* and under 30*s.*	30*s.* and under 40*s.*	40*s.* and under 50*s.*	50*s.* and under 60*s.*	60*s.* and over
British blast-furnacemen[1] (1906)	6·9	32·9	32·3	17·5		3·4
British manufactured iron[1] and steelworkers (1906)	6·2	34·0	29·0	12·3	6·2	12·3
Hörde steel and millmen[2] (1904)		58	25			

The observations of 1895 as to the distribution of wages are thus only partially confirmed. Over half the Westphalian workers came within one wage group; and the median wage, about 27*s.*, coincided with the average. The British median was distinctly below the average, being about 32*s.* 6*d.* or 33*s.* in 1906 for adult workers only, whereas the average for all workers, including

[1] *Report on Earnings and Hours of Labour in* 1906, p. 12.

[2] Ehrenberg, *op. cit.* pp. 169–73, gives the figures on which the line is based. I have assumed a fifty-week year in using his annual figures.

10 per cent who were under 20 years of age,[1] came to the same figure. But when the British median has been adjusted to the lower levels of 1904—it can scarcely have been as low as 30*s*.—it is not as low as the German figure; the implication is that the majority of English adult workers earned a higher wage than the German. This conclusion is supported by the scattered information concerning the wages of specific grades of workers.[2]

Bolckow Vaughan's records for the late 'eighties show a rather different distribution of wages from the Board of Trade figures for 1906. Of the 860 workers whose wages averaged almost 5*s*. per shift in 1888, rather less than half earned 4*s*. or more.[3] The median was far below the average; there was a big

[1] Hörde figures may include some boys: but very few of the German workers whose wages were enumerated can have been boys. Out of 387 mill workers whose wages are given only 14 earned below £45. There is reason to suspect that low wages were eliminated; perhaps, as suggested by Jeidels (see above, p. 131, n. 2), taken into general costs.

[2] Steelmelters' wages, for example, in thirteen important British works averaged £7. 6*s*. for first hands in 1906, £3. 11*s*. 6*d*. for third hands. The lowest average for third hands was £2. 14*s*. (unpublished arbitration records). At Hörde in 1904 only seven men in the open-hearth shop earned above 50*s*. a week, and none above 60*s*. (Ehrenberg, *op. cit.* pp. 170–1). At Aachen the "Meister" earned 7*s*. a day, the Vorarbeiter 6*s*. (Rabius, *Die Aachener Hütten-Aktien-Verein in Rote Erde*, 1846–1906, p. 134.) In Oct. 1905 the Board of Trade investigators of Continental working conditions found the upper limit of first smelters' wages to be 36*s*. at Dortmund; the average smelters' wage at Dusseldorf was 35*s*. (*Report on Working Class Rents... and Wages...(in) Germany*, pp. 99, 210). In rolling it was much the same. At Bolckow's in 1900 three men of the plate-rolling gang earned 28*s*. 9*d*.; seven had from 40*s*. to 42*s*. 6*d*.; one had 62*s*. 6*d*. The roller was the contractor, his earnings not recorded. (In 1895, when there was no percentage addition, the rail contractors averaged £11. 10*s*. a week.) In 1905 Dortmund first rollers made 52*s*. to 57*s*. for six shifts (Bolckow Vaughan's worked five); second rollers had from 36*s*. to 39*s*., the rest from 26*s*. to 31*s*. (*ibid.* p. 179). At Aachen the manipulators had from 20*s*. to 27*s*., and only three men on a mill over 30*s*. (Rabius, *op. cit.* p. 134).

[3] It would probably not be possible to establish the position quite accurately on account of the working of the contract system. The records of the 'nineties show that the remuneration to be paid by contractors to those whom they employed was often specified by the firm. But it is understood that firms did nothing to see that the terms were actually kept. By 1895 the contract system was losing ground in the industry. The Barrow Bessemer shop ceased to be a contract shop in 1886: a reduction of 10 per cent in the contract rate with the superseding of contracting brought a 14 per cent rise of wages to most of the men (*R.C. on Labour*, Evidence (Group A), Q. 14,966). Though the contract system was said to be going in the early 'nineties (*ibid. loc. cit.*) it was a long time a-dying, and succumbed piecemeal. It was abolished in the Sheffield forges and armour-plate mills in the depression of the

bunch of low-paid men. The median was actually very close to the Westphalian average at this date, though not quite so low.[1] But it is probable that the Westphalian median was also below the average; for it was characteristic of the German industry, as of the British, for the wages of the poorly paid workers to advance more nearly to those of the highly paid through the late 'eighties and the 'nineties.[2]

At the time of the successful German tariff-reform campaign all observers were agreed that the disparity of British and Westphalian ironworkers' wages was in part offset by the greater capacity of the British worker. It was not suggested that he was more skilled, but that he had more muscle. By 1900 it is probable that the difference of capacity had been greatly abridged. There is evidence of this from two different angles. It has been seen that the delegates of 1895 "were greatly struck" by the physique of the workers whom they came across. "Let those who run down the German workman come over and see what he can do", wrote another delegation—of artisan engineers—ten years later;[3] and Alfred Marshall in 1903 commented on "the levelling up, almost incredible to anyone who has not watched it step by step". "Now the difference between the hour's work in the most progressive parts of Germany and the English hour's work is relatively small."[4] By the side of this evidence of "levelling up" there are significant criticisms of the quality of the British labour supply. Charles Kirchoff, editor of the American journal *Iron Age*, after a tour of the chief Continental centres, "confessed to some disappointment at the men whom he saw in the mines and iron plants of Great Britain. They are not the sturdy vigorous type whom he expected. The clear cut physique of the younger middle class Englishman, the

early nineteen-hundreds (*Engineering*, Jan. 1, 1904, p. 16); in the sheet-rolling mills of Messrs John Summers it went in 1911, to the accompaniment of a disturbing conflict between the contractors' union (the Ironworkers' Union) and the Siemens Steelworkers' Union, which took up the case of the unskilled workers. The position was discussed in an interesting leader in *I.C.T.R.* July 28, 1911, p. 138.

[1] Above, p. 132.

[2] Ehrenberg, *op. cit.* pp. 153–63.

[3] *Gainsborough Commission Report*, p. 24.

[4] A. Marshall, *Official Papers, Fiscal Policy of International Trade*, p. 379.

love of outdoor sports and constant exercise, is not characteristic of many of the workmen. It seemed difficult to dispel the notion that possibly a century of conquest, colonisation and emigration has drained Great Britain of a notable percentage of its best men, leaving a distinctly deteriorated race behind".[1] A few years later English witnesses give the same impression. Lady Bell, for example, in a study of the conditions of the ironworkers of Middlesbrough which took its inspiration from the work of Charles Booth, remarked in 1907 how "One is apt to be surprised to find how many of the workers are more or less ailing in different ways";[2] and in the same year a Midland owner, Walter Somers, in his presidential address to the South Staffordshire Iron and Steel Institute was urging the adoption of measures "such as will raise the physical condition of the men to a higher state of efficiency".[3] This was a new note in the owners' discussions of the ironworkers, which accords well with the view that relative efficiencies were changing in the industry. Such a change was to be looked for as the rapid rise of wages in Germany brought more workers there above the poverty line, and was all the more likely since, on account of the traditions of economy in Germany, and perhaps of those schools of housewifery in which all the *Jubilee Festschrifts* of the great firms glory,[4] incomes may have been used more skilfully there than in Britain.

Whether the Westphalian worker had caught up the English in physique cannot be known. On such matters statistics are silent: there are output figures consistent with the view that he had, but since no identical plants existed to form the basis of a comparison, and since the division of work between the "hands" varied in different plants, it is idle to look for proof. The trend was clear. Meanwhile, another trend was reducing the significance of the old contrast: the qualities required in a

[1] *Iron Age*, Aug. 9, 1900, p. 3.
[2] Lady Bell, *At the Works*, 1911 ed., p. 136.
[3] *Proc. S. Staffs. Inst.* XXII, p. 8.
[4] A great many German firms, and firms of other Continental countries, have published elaborate and often useful reviews of their history when they have reached a fiftieth or hundredth anniversary. Several are quoted in the text.

workman were being changed by the advance of labour-saving plant. Nervous energy, as Marx put it, was taking the place of muscular energy, and though for most steelworks' jobs the men needed some training—often short—a rapidly decreasing number required either great strength or handicraft skill. Parallel with the decreasing importance of these qualities, the value of order and discipline grew. The satisfactory working of a plant depended increasingly on the orderly performance of mechanical functions by a defined number of men: there were relatively few points in a works at which the number of men employed was variable—could, that is, be greater in European than in English plants. Work became more continuous and, in a sense, more intense.[1] It was perhaps in response to this greater continuity that where heavy muscular labour remained to be done, German works appear to have introduced frequently what was in effect an eight-hour day for the workmen concerned.[2] For the types of work which were growing more common the Westphalian workman probably never suffered in any comparison with his competitors. Discipline was endemic—or epidemic. The orderliness of Krupp's routine had impressed countless visitors. In addition the German workman was better educated than his opposite number in England, which became significant where trained intelligence counted more than craftsmanship.[3] Great disparity of efficiency was thus scarcely to be expected in a labour-saving plant. It is interesting that, as early as the 'eighties, shipbuilders on the North-East Coast were observing the equalising influence of the new machines: "the foreign workman", one of them wrote, "is equal to our own so far as manipulative skill goes, and although the physical and racial differences give our workmen an immense advantage,

[1] This is treated by Ehrenberg, with a German taste for classification, *op. cit.* pp. 115 sqq.

[2] At Hörde there was a three-shift system for cupola workers charging spiegel: and since 1895 there were three men for two jobs in manipulative work at rolling mills: Ehrenberg, *op. cit.* pp. 98, 107. H. M. Punnett regarded this employment of surplus men as a good characteristic of German labour policy; a large mill staff might in fact mean bigger output: *Trans. S. Staffs. Inst.* XI, p. 94.

[3] Not that the Westphalian was likely to be lacking as a craftsman: there was a fine metallurgical tradition.

this is already almost counterbalanced by the help of the machine tool."[1]

One factor alone was likely to check the advance in relative efficiency of Westphalian labour. A rapidly growing industry necessarily carries a burden of learners proportionately more heavy than is borne by a less expansive industry, and there may be a relatively high rate of labour turnover, since individuals will be more frequently tempted to better their position. There are signs that the Westphalian makers thought they suffered from a high rate of labour turnover.[2] Their more serious problem, however, was that they could not recruit enough new labour locally: after 1890 it was necessary to employ increasingly large numbers of East Prussians, many of them Poles, both in the mines and in the iron and steelworks, and there were some foreign workers too, mainly Italians.[3] It appeared to be a reasonable conclusion in 1905 that the Poles ultimately became as efficient workers as the Germans—they earned equally high wages in the coal mines when they were experienced.[4] Probably the Italians were never as efficient—they certainly became less quickly acclimatised—but they played a small part in Westphalia, migrating more numerously to Lorraine.[5] Some of the Poles and most of the Italians were fortune seekers, aiming at a quick return home to buy land, which was an advantage in so far as it urged them to great efforts; but it intensified labour turnover. It is possible that in mitigation of a heavy rate of labour turnover the Westphalian industry may have carried a relatively small burden of young labour, because it would draw only adult labour from a distance. This would raise average wages, but equally it might raise average efficiency.

For the English maker the recruiting of labour almost certainly proved a less serious problem than for the Westphalian,

[1] *Trans. North-East Coast Institution of Shipbuilders and Engineers*, 1888–9, p. 48. Cf. also 1885, pp. 25–6.

[2] Ehrenberg, *op. cit.* pp. 127–8; Rabius, *op. cit.* p. 142.

[3] It was possible to regard this as a means of keeping wages down, rather than of increasing labour supply. The Social Democrats took this view. Cf. Sombart, *Mod. Kapitalismus*, III, i, pp. 449–50.

[4] *Report on Working Class Rents...and Wages...(in) Germany*, p. 83.

[5] Schumacher, *D. Westdeutsche Eisenindustrie und d. Mosel-Kanaliserung*, p. 32.

though men had sometimes to be drawn from far afield[1] and they were sometimes new not to steelmaking merely, but to manufacture. In Lincolnshire and Cleveland there are still open-hearth melters of the first generation, who came from the land, with little education, but with great strength for the charging of furnaces. The difficulties, however, which were probably more serious for British makers in international competition, which may indeed have balanced the Westphalian drawback from labour turnover, were of a different character, and have both been referred to already. First, the men had a reputation for irregularity in attendance at work[2]—"there were too many drunks"—or the work was too exhausting, which was no doubt true, and was accentuated where the wages if not inadequate were unskilfully used.[3] Probably the workers had not lost the tradition of spasmodic activity associated with handicraft industry; it was a tradition which puddling might nurture, and which rolling might tolerate if the plant were primitive.[4] The second difficulty was an inclination of workers to go slow. In steel this was associated generally with the introduction of new equipment, where there were problems of rate fixing.[5] In the declining malleable-iron industry it was, and had been, chronic. American observers, men and masters alike, were impressed with the restricted pace of English workers, regarding it usually as a result of strong organisation. As early as 1875 opinion was clearly formulated: "We must steer clear as far as possible of Englishmen, who are great sticklers for high

[1] Cp. above, p. 123.

[2] The wage report is consistent with the existence of much irregularity, and the habit was not merely ascribed to the men by the masters, but was eventually acknowledged by their leaders as well. Cp. above, p. 137.

[3] Lady Bell, *op. cit. passim*, emphasises both the irregularity ("the men are constantly breaking down in health...") and the lack of skill in using income. A third of the large sample of families in Cleveland which she examined were living on or below the poverty line, though only one-seventh (a large enough proportion) were so because of their incomes (p. 84).

[4] The absence of one puddler in a shop would not disorganise the whole shop; and if a rolling mill were primitive, capital costs would be low in relation to labour cost.

[5] E.g. J. W. Hall, *Proc. S. Staffs. Inst.* IX, p. 102. It might, however, take another form, the insistence of workmen on the retaining of the same staff on new labour-saving plant or on the plant which replaced it: *R. Tariff Comm.* § 624.

wages, small production and strikes", wrote Captain Jones to one of the partners in the Edgar Allen steelworks, then in process of organisation. "Germans and Irish, Swedes and what I denominate 'Buckwheats' (young American country boys) judiciously mixed make the most tractable force. Scotsmen do very well... Welsh can be used in limited numbers.... Englishmen have been the worst class of men I have had anything to do with: and this is the opinion of Holley, and George and John Fritz."[1] At the close of the century Schwab held the same views, and they were perhaps partly an inheritance. Apparently the migrants from Wales lost all inclination to restrict output—fortune-seeking Welsh "tin-hogs", indeed, had become a bugbear of American trade unionists by the time of the Industrial Commission.[2]

In all probability then the disparity between iron and steelworkers' wages in Westphalia and Great Britain was not fully, if at all, counterbalanced in the early nineteen-hundreds by greater efficiency of British labour; for while the difference of wages had lessened since Bell wrote, the difference of efficiency had probably declined still more. In the low-wage areas of Germany, and of the Continent as a whole, there was no doubt a level of efficiency still appreciably below the British; and where some of the labour was transitory, and most was new, as in Lorraine, there was a lack of skill as well as of muscle. But even here the introduction of modern plant considerably modified the contrast of productiveness, and where a refined product was not sought it is likely that the gap between British and Lorraine wages, never less than 30 per cent, was reflected to some extent in the real cost of labour. The British maker may

[1] Quoted in J. W. Bridge, *Inside History of the Carnegie Steel Company*, p. 81. It is noticeable that English workers formed a relatively small proportion of the samples of United States iron and steelworkers studied by Wright for the *Report* quoted frequently above. There is nothing, moreover, in the wage averages given to suggest greater efficiency of British than German workers: but the data are not sufficient to form the basis of an established conclusion.

[2] *Report of U.S. Industrial Commission*, vol. XIII, pp. 460 (Schwab) and 392–3 (Schaffer). Restriction of output was a practice prior to the time at which English output had ceased to expand: it is not to be regarded as a result of stationary output. Cp. e.g. Bell, *Manufacture of Iron*, p. 582.

well have been as badly off as regards the real cost of labour as Bell had pictured him in the preceding generation.

This conclusion is easily reconciled with the fact that many British steelmakers, indeed most, appeared to rate the burden of high wages much lower than their forerunners had done. The significance of American competition in this regard has been mentioned. Competition came successfully from a country with wages 50 per cent or more above the British standard.[1] The time-honoured case of the ironmasters was not applicable. British labour management might be at fault, trade unions might be too powerful, the State too well disposed towards wage earners,[2] but high wages in themselves were not the cause of discomfiture. On the other hand, the tariff was an influence favouring American and German competition alike. It did not have much to do with Belgian advance; but Belgium, after all, was a small country.

The reaction to American competition was only superficially logical. It drew its force from the expectation that American exports, at present far less in volume than those from the Continent, would rapidly outstrip them. Save for this foreboding there was much in the information available about the American industry which might have added fuel to the old fires: American makers regarded their labour as involving more real cost than Europe's, and claimed only to obtain relatively low labour costs in the large-scale mechanised production of heavy products.

The supposed implications of American advance were probably fortified by the decline of labour costs in pig iron and steelmaking since the 'seventies. In both, as will be shown, larger-scale operations had resulted in lower labour costs. In

[1] Wright's figures, quoted above, p. 123, are probably not misleading.

[2] E.g. a leader in *The Times*, Jan. 6, 1902: "The (Moseley) Commissioners will find that things go better in America because everybody minds his own business. Employers do their own protection against tyranny...and their own conciliation to avoid battles with powerful associations....The State does its part in collecting information of public utility, and in seeing that the principles of individual liberty are maintained." Did this mean Homestead and Pinkertons? It was the American competition which inspired most, but not all, of the complaints concerning the character of English workmen at this date.

the malleable-iron industry the trend had been otherwise; demand did not invite larger outputs, and puddling, far more expensive of labour than steelmelting, was a process insufficiently mechanised to allow a progressive reduction of labour costs. Malleable-iron makers still proclaimed the evils of high wages during Chamberlain's campaign with some of the fervour of the earlier generation.[1] But the steelmaker, whose labour cost in turning ore into rails or girders or semi-products came to about 15*s.* a ton, was necessarily not disposed to ascribe major importance in competition to an unfavourable disparity of 10 or even 20 per cent in the real cost of labour; for he measured the influence of the tariff by the gap between his Continental competitors' home and export prices, which was frequently in excess of 15*s.* a ton, in excess, that is, of the whole of his labour cost. Even a generous allowance for the influence of labour-cost disparity in mining and transport was unlikely to disturb the significance of this contrast.

In any case the remedy for unfavourable foreign tariffs appeared to the steelmaker to be a remedy also for high wages, without the obloquy and friction of wage reductions, and with more prospect of success; with the possible additional advantage, moreover, of a fall in direct taxation. So it is not difficult to understand why the wage problem should be "put away and forgotten". But the fundamental significance of a difference in the cost of labour cannot be determined from the angle of the steelmakers' approach; it can be judged, as in the 'seventies, only in relation to other elements affecting costs in the industry —raw-material supplies, marketing facilities, financial structure, technical skill.

[1] E.g. W. H. Bleckly, of Pearson Knowles and Company, the Lancashire malleable-iron makers, at the annual meeting of the firm, *Econ.* Oct. 1, 1904, p. 1587.

Chapter IX

NEW ORES FOR STEEL; OR, THE ADVANTAGES OF LOCATION

In the 'seventies what British iron or steelmakers lost on wages they probably made up on raw materials. Their ores and coal were at least as cheaply worked as those of their rivals, with the possible exception of the States, and although it was now rare for them to find ore and coal together, the distance between their ores and good coking coal was far less than for Continental and American makers, and the assembling points of the foreign materials were less well placed for export business than the chief British centres. Even where in Britain mining or transport costs were relatively heavy, as they were for the pig iron used for steel, the combined costs for similar pig elsewhere were heavier still.

By the close of the century all this had changed. More and cheaper ores had become available for competitors' steel, and were being used; new ore fields had been opened up, better methods of mining had been adopted, and transport costs had been greatly lessened by technical improvements and by favourable rate policies. In Britain, too, more and cheaper ores became available, but they were being used only to a slight extent, and transport facilities had scarcely been either improved or cheapened.

The most astonishing changes occurred in the States. The extension of mining round Lake Superior had culminated in the discovery of the richest of the deposits, the Mesabi range, where much of the ore could be worked amazingly cheaply by giant steam shovels. Alongside this there was an equally important, perhaps fundamentally more important, change in the organisation of the transport of ore to Chicago and Pittsburg.[1] The canal

[1] There was a continuous stream of European literature on this from the 'nineties onward: e.g. *Engineering*, Oct. 16. 1890, p. 438, reprinting a long American

connexions between the lakes were improved in 1883 to allow 3000-ton vessels to enter the trade, and after 1895 vessels of far higher tonnages—up to 10,000—were provided for.[1] The opportunities were not neglected, and already in the early 'nineties European observers were impressed at the changes in progress; specially designed ore ships, with ten or more hatches to allow rapid loading and unloading, were normal, and dock equipment which both saved labour and hastened the working was introduced. Mechanical grabs, and ore bridges for piling the material, and loading spouts placed to match the many hatches of the ships, replaced hand shovelling and wheelbarrow work. By the mid-'nineties 3000 tons of ore could be loaded in a ship in an hour. In 1894 300 tons could be unloaded in the same time; a few years later it was 600 tons, and by 1904 it was 2500 tons.[2] Improvement of ships and docks was accompanied by improvement of railway facilities. Already in the mid-'eighties the Minnesota Iron Company brought the ore from its Vermilion range mine to its port in trains of 500 tons, each wagon carrying 24 tons.[3] A decade later the Carnegie Company was providing even more impressively for the other end of the transport—from Lake Erie to Pittsburg—by building a railway equipped with 45-ton trucks to be run in trains of 1500 tons, at a reputed cost of one-seventh of a penny per ton per mile. As a complement to this cheapening of the cost of assembling raw materials, there was also a reduction in the rail costs of transporting the finished products. The general trend of all rates for long hauls was downwards after 1880;[4] and Schwab found that the railways, unlike labour, were always ready "to give you a good price for export stuff".[5]

article on the beginnings of the change; Kinzlé, in *Zeitschr. deutsche Ingenieure*, XXXVIII, p. 989 (1894); Jeremiah Head at the British Association, *Engineering*, Sept. 30, 1898, p. 416 (also *ibid.* pp. 355–7); *American Industrial Competition*, 1902 (Report for the British Iron Trade Association), *passim*. Cp. also Mussey, *Combinations in the Mining Industry* (1905).

[1] Mussey, *op. cit.* pp. 82, 130.

[2] E. P. Martin, Presidential Address in *Trans. Inst. Mech. Eng.* 1905, p. 349.

[3] Mussey, *op. cit.* p. 91. Most of the Lake Superior mines were 40 miles or more from the lake shore. The Minnesota Company sent to Chicago mainly, being associated with the Illinois Steel Company.

[4] E.g. cf. Ripley, *Railway Rates*, pp. 432 sqq.

[5] *U.S. Indust. Comm.* XIII, p. 454.

There was in these years a secondary change in America of great potential importance, though overshadowed both by the scale and the engineering skill of the development on the Lakes; for it was now that the mineral resources of Alabama and Tennessee began to be extensively worked. Ores and coal occurred here together, and labour was cheap; pig iron could be made far more cheaply than in the North, and some, it has been seen, was exported to England in the late 'nineties.[1] The pig iron was phosphoric, mostly of foundry quality, and suffered through the lack of a local market. By 1900 it had been used in basic open-hearth steelmaking, which offered a local consumption, if only for railmaking for the South.

Probably rather over half the Lake ores were of Bessemer quality; hence the discovery of the basic process was not an essential foundation of the major growth of American steelmaking at this date.[2] For all that, dephosphorising was of some significance even in the North, since it made all the Lake deposits available for steel; and by 1900 a quarter of American steel (indeed almost all the open-hearth steel) was basic.

In the late 'nineties, when the Mesabi mines had been well opened and American iron and steel was beginning to penetrate the home markets of competitors, some experienced European ironmasters put the cost of ore (60 per cent iron) at Pittsburg as low as 10*s*. 6*d*. a ton.[3] This figure was almost certainly alarmist, referring only to the price of the cheapest ore, which was not used alone satisfactorily. Jeremiah Head's estimate of 12*s*. 6*d*. per ton for 1896 seems to be more in keeping with available details of cost.[4] It is unlikely that the transport cost on Mesabi

[1] *Report of U.S. Indust. Comm.* XIII, pp. 512–4.

[2] Mussey, *op. cit.* pp. 39 sqq. In the early nineteen-hundreds it became most advantageous to use all the ores. Cp. Judge Gary's "Tariff Testimony", in *Iron Age*, 1908, p. 1898.

[3] E.g. P. Trasenter in *Rev. Univ. d. Mines*, 1897, II, p. 110.

[4] J. Head quoted in *Amer. Indust. Compet.* p. 117, where cost details are also given. Freight costs were known, since they were published and almost certainly not subject to rebates. The rail costs to Lake Superior came to 2*s*. 11*d*. at the minimum, usually 3*s*. 3*d*.; and the Lake trip cost the same—astonishingly less than the Bilbao-Cardiff freights which were helped by the return freight of coal. It is unlikely the 140-mile journey from Cleveland or Conneaut would be reasonably priced at less than 1*s*. 6*d*. even on Carnegie's own railway. Julian Kennedy, who was a railway

ore was much below 8*s.* a ton to Pittsburg—a remarkably low figure since there were two railway journeys each of about 100 miles, and a lake transport longer than the trip from Bilbao to Cardiff, which together with one of the rail trips did not have the help of the return freight. Between 1896 and 1900 costs were rising; at the later date half the Mesabi ore was obtained by underground mining, not quarried. Most of the other Lake Superior ores which were used to mix with Mesabi ore were mined and, being harder, were more expensive to get; and some were less rich in iron—Menominee ore was sold, for instance, with only 40 per cent iron.[1] By 1900 even the Mesabi ore used was beginning to have a lower average iron content.[2] Pittsburg had astonishingly cheap coke—7*s.* a ton at the furnaces in 1896 according to Head, but rather more in 1900. When the British Iron Trade Association sent delegates to survey the competitive position in 1902, they reckoned the mineral burden of a Pittsburg furnace to cost 34*s.* This was 10*s.* less than Lowthian Bell's figure for 1890,[3] and the comparison shows the magnitude of the revolution which had occurred. Iron for the basic open-hearth process could have been made from rather cheaper materials.[4] In Alabama the materials cost may have been 5*s.* less again.

On the Continent the change in steelmakers' raw-material costs came less from amelioration of transport and mining methods—though there were considerable changes here—than

director, priced the trip at 1*s.* 8*d.* when the Steel Corporation charged 4*s.* (Stanley Committee, *Iron Age*, April 4, 1912, p. 890); and the equal journey of coke to Pittsburg earned a 3*s.* freight. In open-cast mines labour costs were 5*d.* a ton, in underground mines 2*s.* Most Mesabi ore had a royalty of 1*s.* a ton in the 'nineties (some carried a much higher royalty, of 3*s.* 6*d.*, after 1905), and there was a cost for uncovering ore in quarries which for some of the later Mesabi workings was put at 6*d.* a ton (*Iron Age*, April, 1912, pp. 980–1).

[1] Mussey, *op. cit.* pp. 39 sqq.

[2] By 1912 it was stated that the average iron content of Mesabi ore had dropped 7 per cent, though for the whole of the Lake Superior ore the drop was only 1 per cent (*Iron Age*, April 1912, p. 1006). Jeans gave the tonnage of Mesabi ore used in 1895 as 2·8 million tons out of a total Lake Superior output of 10·5 millions; in 1902 the figures were 12·9 millions and 24·3 (*Rep. Tariff Comm.* § 956).

[3] *Amer. Indust. Compet.* pp. 115 sqq.

[4] The Bureau of Corporations found in 1907 that the difference in cost of Bessemer and non-Bessemer pig was about 2*s.* per ton.

from the discovery of the basic process, which, as has been seen, made both the cheapest French and German ores, the minette, and (perhaps of equal importance) the very high-grade phosphoric ores of Sweden available for steel.

The minette ores were almost as easily worked as those at Mesabi, and because of cheaper labour they were probably as cheaply obtained with less elaborate equipment. At one of the Luxemburg open-worked mines the use of electrical drills raised the daily output per man from 5 tons in 1895 to 8 tons in 1904, which meant a labour cost of 6*d.* a ton or less.[1] Minette ore, 34 per cent iron, never cost more than 3*s.* a ton in the market in the early nineteen-hundreds, and its extraction cost was appreciably below this. In some districts—in Luxemburg, and at Briey and Hayange—siliceous and limy ores were found in different strata in the same mines, and it was possible to obtain a self-fluxing mixture which compensated to some extent for the leanness of the ore. The phosphorous content of these ores, very regular and fairly high, suited them ideally to Thomas's process in the early days. Swedish ore was hard, and necessarily more expensive to get than minette. But it contained far more iron, averaging 60 per cent, and because of this it was cheaper to handle at the furnaces, since less was needed for a ton of pig, and it was also by reason of its purity more suited to the making of higher-grade steels.[2]

Minette ores formed the basis of the steel industry in Lorraine, both German and French, and in the Saar and Luxemburg, and they replaced Spanish ore as the basis of the Belgian industry, particularly after 1894 when the "basic" royalty payments ceased. In Westphalia minette also played an important, but through the 'nineties a growingly less important, part in the advance of steelmaking. In the 'eighties a very considerable

[1] Rabius, *op. cit.* p. 97. The daily wages were 5*s.* for skilled men, 3*s.* for unskilled. The electric drill raised the proportion of unskilled (loading) labour employed. Not all the ore was so cheaply obtained; Jeans, in *Rep. Tariff Comm.* § 963, gives the average annual output per man in Luxemburg mines as 985 tons in 1899.

[2] A useful picture is given by G. Goldstein, *Die Entwicklung der deutschen Roheisenindustrie*, a series of articles published in *Verhand. d. Vereins z. Beförderung d. Gewerbefleisses*, 1908–9.

tonnage both of pig iron and of ore was brought from Luxemburg and Lorraine, and many Westphalian steelmakers bought minette lands. After 1890 less pig iron was brought into the district (since direct working was a bigger economy after the adoption of the "mixer"),[1] and the use of Swedish ore began and rapidly grew.[2] The railway rate on minette was heavy—it was 9*s*. a ton in 1879, and very little less in 1890.[3] The Swedish mines had been opened up by new railways, largely as a result of the Thomas process, and could be brought to the Rhine ports as cheaply (per ton of ore) as minette from Lorraine. With this development the locational strength of Westphalia was very greatly increased. Competition of river and rail made the journey from Rotterdam to Düsseldorf cheap in both directions; and now competition between two supplies of ore, one from the North, one from the South, promised good terms both from the mine and the transport services. In 1893 this was reflected by an appreciable drop in the minette freights.[4] At the outset Swedish ore was only largely used by plants, like the Rheinische Stahlwerke, which were near the river; and the river during the 'nineties proved to be a magnet, drawing new plants to its banks. Krupp started the blast furnaces at Rheinhausen in 1896,[5] when Thyssen's new giant "Deutscher Kaiser" furnaces were already in blast.[6] At the close of the decade, however, Swedish ore became more generally available in the district with the opening of the Dortmund-Ems canal; an event which almost coincided with a final reduction of the minette freight to just over 5*s*. a ton. The canal did not put the East-Westphalian makers on a level with the Rhine makers, since the Rhine freight was 1*s*. a ton and the canal rate was 2*s*. 6*d*.: but the

[1] The mixer was adopted at Hörde in 1889. Although planned and half-developed in the 'seventies (above, p. 50) its development was arrested.

[2] 60,000 tons of Swedish ore were used in 1890, 1,500,000 in 1900, 2,500,000 in 1905: Goldstein, *op. cit.* p. 190.

[3] The minette rate problem is discussed by Goldstein, *op. cit.* pp. 318–19, and by Schumacher, *op. cit.* p. 78 and *passim*. Both writers deal with improvements of facilities, etc.

[4] Minette rates, Lorraine to Westphalia, were 7*s*. 10*d*. from 1881 to 1893, and then fell to 6*s*. 6*d*., and in 1901 to 5*s*. 4*d*.

[5] *Krupp*, 1812–1912, pp. 343–4. Krupp considered building in Lorraine. Steelworks were started at Rheinhausen in 1902: *ibid*. p. 325.

[6] *Stahl u. Eisen*, 1896, p. 264.

eastern makers were near the coking coal.[1] It is possible that the ore freights themselves on the river were no lower in 1900 than in 1880; but the total cost of the Rhine transit was lower, since there were specially designed ore boats, adapted to the mechanical equipment which was used at Rotterdam to transfer ore from the seagoing vessels to the river boats, and to the mechanical unloading equipment on the American pattern which was installed at the works.[2]

None of these changes could make Westphalia a cheap centre for ore, but it was appreciably cheaper as a basic steel centre than for acid steel. Had minette alone been charged after 1900 the ore cost would have come to about 22*s*. (of which 15*s*. was transport cost) according to market prices and published freights. Spanish hematite was rarely lower than 15*s*. a ton at the German Rhine ports—making an ore cost of 30*s*. In practice the Westphalian makers used a burden costing more than minette, less than Spanish—possibly 25*s*. or rather more.[3] Swedish ore always cost less than Spanish in relation to iron content. Much Spanish ore was still consumed, but apart from what was used for hematite steel it was used not for steelmaking but for foundry pig.[4] The basic pig made with Swedish ore, and the local manganiferous ores of Nassau and Siegen, and a little minette, was very free from both sulphur and silicon, and for this reason conversion to steel was cheap. Westphalian makers had the cheapest fuel in Germany to compensate for the transport cost on their ores: possibly it was the cheapest in Europe, for while a little more difficult to "get" than the best British coal it was mined with much cheaper labour, and the coking methods, as will be seen later, were incomparably more economical. The Ruhr market price of coke—15*s*. a ton at the coke

[1] The cost position about 1900 was dealt with by Brügmann in *J.I.S. Inst.* 1901, II, p. 17 sqq.

[2] The development is treated by F. Schulte, *Die Rheinschiffahrt und der Eisenbahnen*, pp. 429–60, and W. Nasse, *Die Rhein als Wasserstrasse*, pp. 251–300, and *passim*.

[3] When the market price of Swedish ore was 17*s*., a wholly Swedish ore burden would cost 27*s*. Direct participation of German steelworks in Swedish ore mines appears to have been infrequent, so far as published records show. I know of only three instances—the Dortmund Union, Bochum and Hösch.

[4] Brügmann, *op. cit.* p. 22. Goldstein seems to be in error here.

ovens in the early nineteen-hundreds—was 3*s*. or 4*s*. a ton higher than the British, but costs for pig-iron makers who owned some of their coal supplies (they were the majority) were certainly below British costs—perhaps below 11*s*. a ton at the blast furnace.[1]

Steelmakers in the Saar and in Lorraine and Luxemburg had far dearer fuel than the Westphalian makers, drawing indeed largely on the Ruhr for their supplies. Saar makers had coal of their own, but it made a friable coke only to be used in a mixture with better fuel. Luxemburg could draw on Belgian supplies, but the Belgian coal was dearer to mine than Westphalian and also made less good coke. The importance to all the minette centres of the Ruhr coke was reflected in the railway rates, for whereas the rate on Lorraine ore to Westphalia had fallen from 9*s*. 0*d*. to 5*s*. 4*d*. by 1900, the rate on coke from Bochum to Lorraine had fallen only by about 2*s*. 0*d*. to 7*s*. 6*d*. More coke was carried south than ore north, and it was no doubt good railway policy to make concessions in the more competitive trade.[2] That ore and coke freights both fell was due to the growing volume of the trades, to a State policy of encouraging heavy industries, and to improvements in equipment, but these were not on an American scale. From 1890 onwards 15 ton wagons were coming into the trades—there was a rise of 24 per cent in the average capacity of German (State) railway wagons between 1890 and 1900. By 1906 57 per cent of the wagons used were 15-tonners; but 20-tonners made of steel on American patterns designed for mechanical unloading were only just coming in, and the railways had so far opposed the use of mechanical wagon "tipples".[3]

[1] Brügmann estimated transport cost to blast furnaces as 1*s*. per ton; if coal were taken, and not coke, the cost was higher. B. Simmersbach, *Gelsenkirchener Bergwerks-Aktiengesellschaft*, p. 79, gives figures of labour cost, at 3*s*. 3*d*. per ton of coal in 1894 and 4*s*. 5*d*. in 1904, considerably above Durham costs. But less coal was needed for the coke, and by-products were sold.

[2] But the relative rates may in part have been an index of the political influence of the Westphalian steel interests, which was also being exercised with success to hold up the canalising of the Moselle, to the detriment of Lorraine.

[3] Goldstein, *op. cit.* p. 535. It is of interest that when minette rates on the railway had been high the Westphalian ironmakers had directed their energies to the encouragement of the Moselle canalisation.

Though the cost of transporting their coke was heavy, the steelmakers in the Saar, and still more those in Lorraine and Luxemburg, had lower total transport costs in assembling materials than Westphalian makers using minette. For makers located on the ore fields the difference was about 8*s.* for a ton of pig iron;[1] for the Saar makers the margin was less, and if they avoided transport costs by using their own coal their fuel was more expensive both at the mine and in use.[2] Belgian makers had costs probably close to those in the Saar, having a longer haul for their ore, higher costs than the Ruhr in extracting and using their coal, but no appreciable cost in transporting it.[3] Firms in French Lorraine (whose richness in ore was unknown when Bismarck drew the frontier in 1871 but was being manifested from the middle 'eighties, disastrously for some of the old French firms) may at times have had an advantage in costs over their German neighbours as a result of the Kartell policy of "dumping" coke, but from the point of view of transport alone they were almost identically placed.

If freight burdens alone were considered, users of minette in Westphalia were at a big disadvantage; and there was, as will be seen later, a tendency for Westphalian makers to leave the manufacture of common-grade products more and more to the firms situated on the minette ore fields. The growing use of the higher-grade Swedish ores was perhaps an outcome of this. At the same time the district had some advantages to offset the mineral transport handicap, which narrowed down appreciably the advantages of Lorraine makers. Briefly there were three. First, most Westphalian firms owned their coal mines, while most Lorraine firms did not. The coal Kartell made ownership financially valuable.[4] Secondly, there was a great local market in Westphalia. Thirdly, the district could export more cheaply

[1] Ore freights for Westphalia, 15*s.*; coke freight, 1*s.*; limestone freight, 6*d.*; coke freight for Lorraine, 8*s.* 6*d.*

[2] The quality of Saar coke was, however, considerably improved by changes in the design of ovens and other plant: Goldstein, *op. cit.* p. 529.

[3] The Saar had a freight of 2*s.* or 3*s.* per ton of minette; Belgian coal to Luxemburg and Lorraine had a transport cost of 4*s.* to 4*s.* 6*d.* per ton, and the return ore freight may have been less.

[4] Below, p. 287. Four out of nine firms in the Saar, Lorraine and Luxemburg owned coal mines in 1904; and only one of these had mined coal before 1900.

than Lorraine and the Saar. Railway rates to Antwerp were 7*s.* 6*d.* or 8*s.* from Lorraine, but only 5*s.* or 5*s.* 6*d.* from Westphalia; and firms on the Rhine, at Ruhrort, Duisburg, etc., could export down the river for much lower rates still. Early in the 'eighties river freights to Rotterdam were only 2*s.* a ton, and for some products they were much less by 1900.[1] The route was deservedly popular. In 1872 only 7000 tons went down the river from Ruhrort: it jumped to 77,000 tons in 1875, grew slowly to 143,000 tons in 1900, and then jumped again to 453,000 tons in 1903.[2] These three advantages helped Westphalia as a maker of common-grade products in competition with Lorraine, and the district had still further advantages, notably an admirable supply of skilled labour, for the production of high-grade steel, but this will be considered later.

There was one transport change in the last quarter of the nineteenth century which favoured all the aforementioned competing Continental producers in their export trade, namely the improvement of shipping services and port equipment at Antwerp and Rotterdam. Both harbours were made available for larger ships, and although neither had the volume of trade of London or Liverpool or Glasgow, they had far more than the smaller ports which handled most of the British iron and steel export trade, and as a consequence both probably enjoyed more frequent sailings[3] and better loading facilities. British exporting of steel was dispersed;[4] the Continental trade was forced by nature into two main channels. As ships grew larger, concentration of business became an advantage. Information both on port equipment and on comparative freights is scanty. But it is certain that while Continental ports had lower rates than British ports from time to time after 1890, the reverse situation

[1] E. Crowe, *Consular Report on German Railway Rates*, 1881, LXXXIX, pp. 830 sqq.; *Kont. V. u. d. Kartelle*, IV, pp. 352–6, and *passim*.

[2] Nasse, *op. cit.* pp. 277–8.

[3] Frequent sailings are important advantages for many branches of the steel trade. Presumably they allow not merely the easier accepting of orders for quick delivery, but facilitate economical distribution of work in the mills, etc.

[4] There were appreciable exports from Glasgow, Workington, Barrow, Liverpool, Cardiff, Swansea, Newport, Bristol, London, Hull, Middlesbrough, the Tyne ports, etc.

was rare.[1] Antwerp, for instance, had far cheaper rates to India in 1894 than those charged at British ports.[2] This sort of thing was often an incident in a competition which ended in a "Conference", and equal freights: at other times it may have marked the contrast between tramp and liner services.[3] Large firms in Britain complained less than small firms, so it is possible that the bigger British makers were often able to obtain tramp rates.[4] But in general the pace was set in the freight market by the Continental carriers. English merchants indeed found it profitable at times to export goods indirectly by way of Antwerp instead of directly by way of a home port.[5] Even when a Conference agreement to all appearances equalised freights, the Continental exporter still was able to have an advantage, since out of a joint rail and sea rate (such as were common in Europe, but non-existent in Great Britain) the railway might take nominally a negligible share, but charge the shipping company highly for general warehouse facilities. America had no monopoly in the devising of "smokeless rebates".[6]

Unlike their rivals, most British steelmakers had to pay rather more for their raw materials in the early nineteen-hundreds than in the early 'eighties. This was due to increasing difficulties in obtaining hematite ores, the limited use of phosphoric ores, and the absence of any notable change in transport equipment.

In the decade after 1875 there was a remarkable drop in hematite prices, which was a result first of the competition

[1] For an early discussion, Report on British Iron Trade Association meeting in *I.C.T.R.* Nov. 2, 1894, pp. 553–4. There are fuller discussions in *R.C. on Shipping Rings*, 1909, XLVII, esp. in Jeans' evidence (very badly given). An interesting comparative discussion of dock equipment, emphasising the value of concentrated traffics in Europe, by the manager of the Newport docks, occurs in *I.C.T.R.* Jan. 15, 904, p. 13

[2] *Ibid.* Nov. 2, 1894. In 1903 Antwerp had a rate to Australia 10*s.* below Liverpool rates in 1903: *Rep. Tariff Comm.* § 916.

[3] The United States often gained from "dumping freights" in their trade with South Africa and Australia in the early days of their trade. At one date a rate of 7*s.* 6*d.* was charged when the later stabilised rate was 25*s.*: *R.C. on Shipping Rings, Report*, p. 69, and Qs. 3037–9.

[4] *Ibid.* Jeans' evidence, Q. 8444.

[5] Mr Gray Buchanan, of Messrs William Jacks, gave me information to this effect.

[6] *R.C. on Shipping Rings*, Qs. 9401, 9557, 9567.

between Spanish and West Coast supplies, and secondly of the competition between acid and basic steel. At the outset West Coast ores carried amazingly high royalties, and high profits as well. Spanish prices fell as the district became more fully opened up, better equipped with local transport from mines to ports, and with harbours deepened to accommodate relatively big ships. The sea freights often touched 9*s*. a ton in the middle 'seventies, but were rarely much above 6*s*. a decade later, and often less.[1] By 1886 the "average value" of imported ore, which had been just under 20*s*. a ton in 1877, was about 11*s*. (at the ports); and West Coast ore which had normally been 14*s*. a ton or more in 1877 had fallen below 10*s*. at the mines (of which 1*s*. was the minimum royalty in Lancashire, and 2*s*. in Cumberland).[2] After this date prices rose, and they never reached the low levels again. The average value of imported ore in 1902–4, years of severe competition, was 14*s*. or 15*s*. a ton. The change of trend is explained by use of less accessible and less rich ores. In both districts the cream had been skimmed by the early 'nineties. In the West Coast mines, though the average iron content fell by about 2 per cent between 1890 and 1900 the total output of the district shrank, and the output per worker dropped from over 400 tons a year to under 300 tons: at the lower level labour costs in the district averaged about 5*s*. a ton.[3] In Spain the use of poorer-quality ores made it necessary to screen, wash and even calcine some of the material and, although the workings were all open cast, it is likely that the overburden of earth to remove was heavier in the newer mines. New taxes also added slightly to the cost of Spanish ore,[4] and there was no change in the trade to compensate for increases of cost, since the handling of the import into Great Britain was in no way cheapened. "They were dealing with these ores in the same manner, with tubs and shovels, as 40 or 50 years ago", according to E. P.

[1] 5*s*. 3*d*. was the rate to the North-East Coast in 1886; Bell said it did not pay, but that 6*s*. paid very well: *R.C. on Depression of Trade*, 1886, App. 2, p. 319.

[2] Josiah Smith, *ibid*. Q. 2313; "average value" is the value according to the Board of Trade Statistics.

[3] The figures are drawn from the *Mineral Statistics*.

[4] For the Spanish mines see *J.I.S. Inst.* 1896, II, pp. 40 sqq.; a valuable survey.

Martin, President of the Iron and Steel Institute and Manager of Dowlais, in 1897. "It did not matter much with sailing vessels what the demurrage was", he added, "but in these days every hour in the case of a large steamer was of great importance."[1] Unloading may, in fact, have been becoming a larger cost, through rising "demurrage" and rising wages.

A Middlesbrough works which did not own its ore and coal mines could not have obtained its material for hematite pig in 1902–4 at less than 45*s*. per ton of pig iron, 10*s*. higher than the market price of 1886.[2] The situation was very similar on the West Coast, though here the ore was cheaper and the coke cost more.[3] The West Coast works still for the most part used Durham coke, largely because of its purity, and they had to bring it a journey across the Pennines which, although far shorter than the trip from Bochum to Lorraine, was scarcely less expensive. A considerable number of firms did not, however, purchase their minerals, but owned their own mines; and it is important, therefore, for an international comparison to judge the relation between mining costs and market prices. In times of boom undoubtedly coal prices and ore prices carried a lot of profit, and it was this probably which was the chief incentive to integration in these early stages of steel production. But it is not probable that, save for the more naturally favoured mines, profits were fat in years of severe competition, and this conclusion seems to be largely borne out by the cost information which is available. It is indeed extremely unlikely, from these data, that the mineral costs even for coastal works could have been as low as 40*s*. for a ton of pig,[4] a conclusion which harmon-

[1] *J.I.S. Inst.* 1897, II, p. 20.

[2] Almost 2 tons of ore, at 15*s*. a ton; 2*s*. for limestone, and 14*s*. or more for coke.

[3] The coke cost about 18*s*. or 19*s*. a ton.

[4] Transport costs were the heaviest costs in obtaining Spanish ore. The sea freight was 4*s*. 6*d*. or more—usually more: there was a short but heavy transport in Spain—first by aerial cable to one of several railways, then by rail in mountainous much-tunnelled country. It is unlikely that this cost much less than 1*s*. a ton. Unloading in a British port probably cost as much; a witness before the Tariff Commission, for example, rated the British cost for unloading ore as 6*d*. above the American cost (*Rep. Tariff Comm.* § 665). The work of extracting ore and putting it in trucks cost 1*s*. or 1*s*. 4*d*., and taxes amounted to 8*d*. Removal of the overburden was an additional cost and there were material costs, capital costs, administration,

ises with the fact that Cleveland makers were unwilling to make hematite pig to sell at a price below 50*s*.

Some of the rise in British raw-material costs for hematite steel might possibly have been offset by improved transport. Many experienced observers and participants thought that the cost of shipping and discharging the Spanish ore could have been reduced, and that the carriage of coal was relatively inefficient. In both directions American methods were thought to be applicable. There was clearly no scope for savings such as were realised in the States, for the volume of the British trade was much less. In the ore import trade, for instance, only one British port—Middlesbrough—imported over 1,000,000 tons in 1902, and Glasgow and Cardiff, each with over 800,000, were the only ports handling above half a million tons, though the Tyne ports taken together just reached this figure, and Maryport and Ardrossan were close. Barrow had 370,000, Newport 340,000, Stockton 240,000, Swansea 170,000—and there were nine other ports each handling about 100,000 tons.[1] This

etc., which without any screening or calcining must have brought costs well above 10*s*. a ton. Cp. *J.I.S. Inst.* 1896, II, p. 40. It has been shown in the text that labour costs in the West Coast mines averaged 5*s*. a ton; royalties averaged 1*s*. 6*d*., and there was usually a rail journey to the blast furnaces which for Barrow came to 1*s*. a ton in 1886, though the trip was only three miles. For Workington it cost 1*s*. 10*d*. in 1900 (Billy and Milius, *op. cit.* p. 249). It is unlikely that even a modest profit would be earned at a price below 10*s*. a ton: indeed prime costs must have approached this figure. The labour cost in coal mining at Bell's collieries in the early nineteen-hundreds came to 3*s*. 6*d*. per ton; coking labour cost about 1*s*. 6*d*. or 2*s*.; transport from coal mine to Middlesbrough 2*s*. a ton. There seems no reason to think that where the market price of coke was 14*s*. or 15*s*. pig-iron makers who were not coalowners were appreciably handicapped. The estimate of just over 40*s*. as mineral cost for a ton of pig iron as the minimum figure for Cleveland is in line with Jeans' estimate for the Tariff Commission (*Rep.* § 992); he assumes 5*s*. higher for the West Coast (which may have been right, since West Coast firms used imported ore as well as local ore). Jeans estimated under 30*s*. as the mineral costs in Lorraine-Luxemburg—rather below the figure suggested above—but by a curious error he made the total pig-iron making costs of these districts come out at almost 47*s*., adding a gratuitous 10*s*. to his detailed cost figures. He did the same for Westphalia; and as a result Westphalian basic costs appeared to be above the Cleveland hematite costs, and the minette district basic costs not far behind. The error was not remarked in contemporary criticisms; and Alfred Marshall, who underscored some of the details, made no note against the totals in his copy of the report. It was important for an estimate of the comparative situation.

[1] They handled together 830,000 tons in 1902, an eighth of the total import trade.

scattered business could not gain from mechanising like the concentrated Lake trade; the lesser centres perhaps could not gain at all. The contemporary German practice on the Rhine, together with later British experience, suggests that when the volume of trade approached half a million tons mechanical grabs, and possibly bridge transporters, would have been advantageous; but if the whole of British hematite pig making were to gain from mechanised unloading a greater concentration of production was needed.[1]

With regard to the rail transport of coal and ore it was not seriously doubted that were the services being newly organised it would be better to have larger wagons than the "twopenny halfpenny trucks"[2] (taking on an average seven tons) which were then in service; and a strong case was also made out for larger locomotives and heavier trains, and for reducing the burden of moving "empties" which was imposed by the "private ownership" of about half the wagons.[3] Continental transport was said to avoid the alleged waste of private ownership, but in later development the privately-owned wagon has become common in the heavy industries of the minette region. The use of bigger wagons undoubtedly meant much less tare-weight to load-weight, less wagon capital per ton of load, easier traction and an increase in the capacity of sidings.[4] There were formidable obstacles, however, to a change-over, since existing equipment—dock and works sidings, weighing machines, etc.—were adapted to the small wagons. Hence more was involved than the capital expense of new rolling stock. It was worthless for a mining concern to own big wagons if its consumers could not accommodate them: a railway company could not profitably

[1] There was no scope for specialised ore ships with ten hatches matching ten unloading grabs with bridges attached, for the unloading equipment would have been idle for most of the time. The subdivision of the British trade was greater than the port distribution shows, since works on the Tees sometimes had their own wharves for unloading; Bolckow's, for example, had.

[2] The phrase is E. P. Martin's.

[3] Cp. early instances in *Engineering*, Feb. 12, 1892; a long letter advocates 30-ton trucks; Twinbarrow, in *Proc. Inst. Mech. Eng.* 1900, pp. 557 sqq.

[4] Easier traction, apparently, because a load is easier to draw on few than on many axles; more capacity in sidings because capacity grew more than area.

embark on them if there were only a few potential users; a dock company could not justify a new equipment if only a few exporting firms were likely to require the facilities. Concerted action was necessary if the change was quickly to be a significant economy, or even practicable, and the multiplicity of interests involved, many of them small, put this almost beyond reach. In a bewildering discussion railways blamed the users, and would-be progressive firms blamed the railways, for the absence of change.[1] By 1900 the North-Eastern Railway was introducing steel self-discharging 20-ton wagons, and soon other lines were following the lead. The obstructions were weakening.

Probably for hematite pig iron made on the coast from imported ore the additional burden of railway rates due to inadequate equipment was not serious: the total rail costs in assembling minerals for a well-placed Middlesbrough firm probably did not much exceed 4*s.* a ton of pig. For the West Coast the problem was more serious in view of the long haul of coke, and it was more serious too in the manufacture of pig iron from British phosphoric ores. For makers of "Cleveland" iron, the minimum rail cost was about 7*s.* a ton in the early nineteen-hundreds.[2]

When iron and steelmakers discussed this problem they thought of it, rightly, as part of a wider problem, since the general level of British rail rates was above that in rival centres. Between most British and Continental figures there was no valid comparison; railways may have been badly run, but a study of comparative rates could not prove it. British hauls were mostly short, and the ton-mile rate in such instances misleading. Where journeys of similar length are compared, the British rates were far above competitor rates—it cost 12*s.* per ton, for instance, to

[1] Cp. e.g. *J.I.S. Inst.* 1897, II, pp. 19–20 (E. P. Martin); *Colliery Guardian* leader of Nov. 29, 1901; Report of L.N.W. annual meeting, *The Times*, Aug. 15, 1903; *Proc. S. Staffs. Inst.* XVIII, p. 55. The railways were presumably the best-placed agents to effect the change, since they alone could offer rate reductions; though private owners would gain something even without rate cuts.

[2] This figure was often pitched much higher. I have been able to compare my original guess (7*s.*) with the averages for five plants in 1913. The lowest was 6*s.* 10½*d.* Three were about 8*s.* 9*d.*, one a shilling more. A witness to the Tariff Commission gave 10*s.*: *Rep.* § 529.

send steel from South Staffordshire to London or Liverpool, whereas Liége could send steel to Antwerp for 3*s.* 6*d.*, and Dortmund steel could reach Antwerp for 5*s.* 6*d.*[1] But on the Continent there was a heavy and concentrated traffic on the export routes, with the best rates for big shippers only, while the Staffordshire tonnage was relatively light, supplied mainly by small firms, and not likely to be augmented by rail rate encouragement in face of coastal competition. Hence here again comparison was inconclusive, though it did much to drive a surprising number of iron and steel masters into the ranks of railway nationalisers.[2] Curiously enough, while it was common form for ironmakers to complain of the railway services, the internal transport services of works were frequently inefficient, having inadequate tracks for handling trucks quickly and "marshalling" trains. In many instances ore and coke wagons were used for storage in the absence of bunkers.[3]

The absence of improvements in transport was a far less impressive source of high costs than the comparative neglect of the cheap native phosphoric ores which Sidney Thomas had made available for steel. This was, indeed, the most amazing feature of British steelmaking. Cleveland makers usually sold pig iron made from local ores at 10*s.* a ton below the price of hematite, and this iron with slight adaptation was suited to the open-hearth basic process. If the local ores were mixed with imported ores, manganiferous and perhaps richer in phosphorus, a pig iron suited to the "Thomas" process could be

[1] A lot of material on comparative rates was published in the 'eighties and 'nineties. E.g. in Jeans' evidence to the *S.C. on Railways*, 1881, XIII, p. 390, and *passim*; *R.C. on Trade Depression*, 1886, 2nd Report, I, pp. 345 sqq.; *Rep. Tariff Comm.* § 1055 sqq.

[2] In Middlesbrough this attitude was said to be common in 1870. E. Williams, Bolckow's manager, said railways were like public highways, and everyone had a right to haul at cost prices; a confused attitude with interesting antecedents: *Trans. Nat. Assoc. Prom. Soc. Science*, 1870, p. 455. Also Hickman, and others from Staffordshire, *ibid.* 1884, pp. 648 sqq.; *Trans. Mid. Inst. of Mining and Mech. Eng.* XIV, pp. 375–8 (shows the influence of Mill), and *Engineering*, Sept. 16, 1898, pp. 355–7, reporting the British Association. The President saw much in favour of nationalising: but the practical question was, "Could any Chancellor of the Exchequer venture to add 2*d.* to the Income Tax?"

[3] Cp. Hatch, in *J.I.S. Inst.* 1918, I, pp. 27, 123, 124. They may have been mainly in the Midlands.

made with a mineral burden considerably cheaper than that for hematite pig, and at least as cheap as the burden for Westphalian Thomas pig. These Cleveland irons were not as cheap to make as the irons of the minette district. But in the East Midlands, in Lincolnshire and Northamptonshire, etc., it was probably possible to work at even lower costs than in Luxemburg and Lorraine. Ore similar in most respects to minette, and as easily mined or quarried, existed in great deposits which were far more extensive than those of Cleveland. Its market price was about 2*s.* 6*d.* a ton at the mines, and it was far closer to good coking coal than most of the minette ore was.[1] These East Midland ores fell into several classes,[2] of which two may be distinguished. The Lower Lias ironstones of North Lincolnshire were "limy", rather lean, rather variable in quality, and not very phosphoric. Self-fluxing mixtures could be found locally at the outset, and when this ceased to be possible the ores were easily worked when mixed with a little Northamptonshire ore. Coke consumption was rather high, but it was deemed reasonable to suppose that Lincolnshire pig iron could be sold profitably for 30*s.* a ton in the early nineteen-hundreds.[3] This pig iron had been used with success locally by 1890 for open-hearth steel.[4] It was not sufficiently phosphoric for the Thomas process as this was worked in the early days; but Westphalia (and even Lorraine) makers, in face of growing difficulties in getting high-phosphorus pig iron, as their accumulations of puddle cinder vanished, had found the way to work with 1·8 per cent phosphorus by the late 'nineties, a figure which Lincolnshire could have touched—by keeping phosphorus "in circulation".[5] The

[1] The position was progressively improved by the development of the South Yorks coalfield from the 'nineties on.

[2] For analyses see F. H. Hatch, *Iron and Steel Industries in the U.K. under War Conditions*, pp. 136 sqq.

[3] *J.I.S. Inst.* 1901, I, pp. 118–19, and *Amer. Indust. Compet.* p. 123. The second of these references was not specifically to Lincolnshire, but to "the Midlands". It *may* have referred to South Staffordshire. It would certainly imply the use of East Midland ores. Billets were to cost 67*s.* per ton.

[4] By the Frodingham Iron and Steel Company. The ores were also used with success at Park Gate, and near Leeds by Walter Scott and Company.

[5] The charge of ore coke and flux required in Lincolnshire was lighter than in Cleveland. Cp. F. Clements, *op. cit.* III, p. 35, where useful data on the weights are

"inferior oolites" of Northamptonshire were markedly different from the Lincolnshire ores. They had more phosphorus, being in this respect better adapted to the basic process; they were siliceous and sulphurous, and they had a high "alumina" content. Until recently difficulties were experienced in using them undiluted for the manufacture of basic iron for steel, and some other ores would possibly have had to be charged to form a suitable mixture, but the cost of assembling materials would still have been relatively low.[1] Mixing ores was not exceptional or necessarily costly: it often saved the use of "fluxes". It was normal in many parts of Lorraine. Northamptonshire ores were used regularly in a mixture for the manufacture of basic pig iron in South Staffordshire by the mid-'eighties.

Yet in the early nineteen-hundreds little steel was made from the Midland ores; indeed only one-fifth of the total British make was basic (half of this from Cleveland). Many observers regarded this as the main cause of British weakness, and even Jeans represented it to the Tariff Commission as "one of the most unsatisfactory features of our pig-iron situation", "though",

given. For the phosphorus, *J.I.S. Inst.* 1896, I, p. 46; Brügmann, *ibid.* 1902, II, p. 20 and *Iron Age*, July 5, 1900, p. 11. Kirchoff also shows (*ibid.* Sept. 20, p. 7) that in Cleveland they contemplated the use of basic slag as a blast-furnace charge to raise the phosphorus in the pig iron. Lincolnshire makers have told me the iron would have been suitable for the Thomas process.

[1] The method adopted recently by Stewarts and Lloyds in using Northamptonshire ore at Corby for Thomas steel was based upon American studies of the physical chemistry of slags, which were completed in 1915. The practice is a brilliant application of the results of intense research, conducted outside the industry and with little practical significance in its country of origin. There is no doubt whatever that the method greatly reduces the cost of smelting Northamptonshire ores for the manufacture of steel. It is in doubt whether the ores could have been reduced uniformly for this purpose without the new principles. I have been told authoritatively, but without confirmatory detail, that it has been done. There is impressive opinion on the other side; and the use of ore at Ebbw Vale just after the war was not encouraging. But since there was none of the long intensive local experimenting—intelligent groping in the dark, probably—such as seems to have occurred normally before the basic process was anywhere a complete success—in Westphalia and Lorraine, for example—it is impossible for the layman to dogmatise: and it is not necessary in the present context. It looks as though no one ever tried to use the ore crushed and graded save in the new process. See *J.I.S. Inst.* 1931, I, pp. 182 sqq., where it is assumed by many distinguished steelmakers that the problem was solvable on the old lines, and *ibid.* 1936, II, pp. 547 sqq., in which Dr Colcough describes the Corby method. The discussions of both papers are of great interest.

he added, "it was not the fault of the ironmasters".[1] The explanation of this neglect, which had been understandable in early days[2] but became progressively less so, goes far to account for the fortunes of the British industry at the time of Chamberlain's campaign.

The problem presented most openly here was, why should not British steel be made from the cheapest available minerals. It is to be remarked that a second problem was also involved. For basic steel was from the outset suited to some purposes to which acid steel had not been found well adapted—it was softer and it welded better, hence was better for wire drawing, for tube strip and for blacksmith's work.[3] The problem here was the rivalry not of two kinds of steel, but of steel and of malleable iron. In Germany much of the early basic steel displaced malleable iron, and Sidney Thomas advocated his discovery to South Staffordshire in 1882 wholly from this angle.[4] Where German exports were of this kind of steel (the big exports of tubes, wire, and bar are instances), British makers had mineral resources available which were equally cheap though little used, and there was, from a raw-material standpoint, ground for effective competition.

In so far as the problem concerned acid versus basic steel, the picture given by ore costs exaggerated the real contrast in steel-making costs. The phosphoric ores were less rich in iron than the hematite, and involved rather more handling at the blast furnace, and the basic processes—converter or open hearth—were, for reasons given earlier, more expensive than their "acid" equivalents. It is quite impossible to estimate these additional costs. They were not uniform for all ores and all steels, and a cheaply made pig iron might involve added expense in steel-making: moreover, comparisons of specific instances would have limited value since the character of the equipment and management at different plants was never precisely similar.

In the first edition of his authoritative *Metallurgy of Steel* (1904) F. W. Harbord, who had played an important part in the pioneering of basic steel in Staffordshire, judged that where

[1] *Rep. Tariff Comm.* § 1011.
[2] Above, p. 76.
[3] *Ibid.*
[4] *Proc. S. Staffs. Inst.* Nov. 25, 1882.

good basic pig iron was 6*s*. or 8*s*. cheaper than hematite pig—and this he regarded as normal—Thomas steel was a little cheaper than Bessemer, and basic-Siemens' was rather more certainly cheaper than acid-Siemens' steel; the gap here was being widened by American and German improvements.[1] There is reason to believe that this rather understated the position of the basic products. This is suggested in the first place by the fortunes of the North-Eastern Steelworks, the second Thomas-steel firm to enter the field in Cleveland. Unlike Bolckow Vaughan's, the pioneer firm, the North-Eastern works made nothing but Thomas steel, and it owned neither blast furnaces (till 1896) nor minerals. From its start in 1884 it had an appreciable rail business (where it was competing with acid steel); and shortly after its start it was making profits, which it continued to do satisfactorily to the end of the century.[2] This record is significant because while the gap between costs of basic pig and hematite pig on the Tees possibly remained constant (both costs rising) after the mid-'eighties, the steelmaking costs of the North-Eastern company were reduced in three important ways. First, in 1887, an outlet was obtained for the basic slag; secondly, in 1894 the patent rights in the basic process expired (thus freeing the company from a royalty of about 1*s*. a ton); and, finally, about the same time, the company was enabled by the introduction of the "mixer" to use molten pig iron directly in the converters. Josiah Smith thought basic and acid (Bessemer) railmaking costs[3] about equal in 1886. If this were so it is difficult to suppose they were also equal after 1900, after the three improvements in the basic position above recorded. Now if, as the instance here suggests, a Cleveland firm made basic steel at a cost lower than that of acid steel, works situated on the Midland ores—which were cheaper to obtain than Cleveland ores (being quarried, and not mined), and of which important

[1] Harbord, *op. cit.* 1st ed., p. 207.

[2] Some details were given to the Tariff Commission by Sir Thomas Wrightson ("Witness No. 4"): *Rep.* § 578–84. The fortunes of the company were chequered after 1900, but this was due to (*a*) the high market prices of coal in 1900 (§ 584), (*b*) dumping of semi-products by Germany in Wales, etc.

[3] Necessarily Cleveland basic costs.

quantities could be smelted more cheaply, and could with a small addition of foreign manganiferous ore make a "Thomas" pig—should have been able to obtain a favourable margin. Harbord was presumably thinking not of hypothetical costs but of the costs of existing works. Basic steel made in the Midlands was with few exceptions made in plants rather distant from the ore beds, which had a considerable transport burden on their ores.[1] And until after 1900 the Midland blast furnaces were almost universally less efficient than the Cleveland furnaces. Hence, for two reasons, a "normal" gap between the prices of hematite and basic pig iron failed to show the potential strength of East Midlands for steelmaking, whether in the converter or the open hearth. In open-hearth costs the price of scrap, of course, ranked almost as important as that of pig iron, and in all districts miscellaneous scrap—old wrought iron mainly—was far cheaper because more ample than hematite steel scrap, the gap being often 10*s*. a ton: the scrap position favoured the newer process. There seems thus no reason to doubt that those who, like Jeans and Skelton and Jeremiah Head,[2] thought British steel could have been materially cheaper as well as adapted to more uses if more of it had been basic, were right.

Three forces had stood in the way: the location of British steel ingot production in the late 'seventies (and in a less degree the location of iron making); the unreliable character of much of the early basic steel; and finally the location of iron- and steel-consuming industries.

First, location of ingot making. When the basic process was introduced most British steelmakers stood to lose by it, although it was discovered for British circumstances. North Lancashire and Cumberland obviously were threatened; South Wales could import hematite ores to advantage but could not obtain native

[1] E.g. Hickman paid 3*s*. 3*d*. to 3*s*. 10*d*. per ton of ore in 1881, and possibly no less in 1900; he would use over two tons of ore for his pig iron, perhaps nearly three tons. *S.C. on Railways*, 1882, XIII, Q. 4328. He also paid 1*s*. 7*d*. to 1*s*. 10*d*. per ton of coal for a 6-mile transit, in 1881.

[2] Head at Cleveland Institute of Engineers, report in *Engineering*, 1894, II, p. 496. He put additional cost of manufacturing basic pig iron as 2*s*. 6*d*. For more details, but an equally favourable estimate, see Turner, *Journ. Glasgow and West Scotland*, 1899–1900, pp. 126 sqq.

phosphoric ores cheaply; Scots ores were neither suited to the Thomas process nor cheap; Sheffield was too far away from the Jurassic ores to get them cheaply. In the ore districts most suited to the new process there was no steelmaking, virtually no malleable iron manufacture, and the pig-iron manufacture was young and to all appearances immature:[1] the making of uniform qualities had not been mastered in the 'seventies. Old Midland malleable iron centres, particularly South Staffordshire, were in some respects favourably placed since they had local fuel, local markets, great heaps of "puddle cinder" which could be used advantageously in the blast furnace for Thomas pig[2]—and they were not very remote from the Northampton ores. But the district had practical traditions which were a handicap.

Only for Cleveland and the North-East Coast, of existing steel centres, had the new process much to offer. But since Cleveland was also one of the most favoured sites for acid steelmaking, the success of basic steelmaking here was not a matter of life and death for the district; a factor which probably lessened the concentration on the new process in the district. Bolckow Vaughan's remained through the 'nineties makers of hematite as well as basic steel: like many other British firms—including the relatively nearby works at Consett—they had vested interests in Spanish ores. Cleveland also had another and more serious handicap as the natural experimenting centre for the new process in Britain, since its ores were only moderately rich in phosphorus (a deficiency which had to be compensated for in Thomas steelmaking) but immoderately rich in silicon and sulphur. Blast-furnace managers could remove either the silicon or the sulphur during smelting, but were unable to get rid of both; and both were objectionable for the Thomas process.[3] The sulphur remained in the steel and made it brittle.

[1] There is an article on the Lincolnshire industry, very illuminating, in *J.I.S. Inst.* 1876, pp. 323 sqq.

[2] This was used in Cleveland and in Westphalia too. Originally cheap, regarded as waste, it grew expensive. For Westphalia it rose from 6*s.* in 1885 to 16*s.* in 1895. *Ibid.* 1896, I, p. 410.

[3] For references for this paragraph see below, p. 176.

Silicon destroyed converter linings, necessitated heavy charges of lime flux, made a slag low in phosphorus and of no use as manure, and provoked a violent reaction in the converter which ejected a lot of iron and led to inevitable irregularity in the quality of the steel. Hence the necessity of using a pig made partly of imported and relatively expensive ores. One outcome of this was to limit the commercial success of the North-East Coast basic industry, which might discourage people entering the industry even in more naturally favoured centres.[1] Possibly another outcome was a tendency to cut rather fine the proportion of expensive ingredients used for the basic steel, occasionally at the expense of quality. Many observers, over a long span of years, remarked on a tendency in British basic steelmaking, as contrasted with German, to use very impure materials in lavish quantities.

This leads then to the second influence which hindered the expansion of basic steelmaking, the unreliable quality of much of the early product. At the outset the reception appeared to be kindly, with some tolerance for the inevitable early difficulties. By 1884 Thomas steel made on the North-East Coast had been used for a great variety of purposes—rails, wire rod, tin plate bars, ship angles, hinge steel, etc.—and the makers claimed success in all these uses. A year later the new steel "had come rapidly into use in Scotland" for ship plates, baling hoops, tubes, etc.—so rapidly as to encourage the erection of two Thomas plants, one at Glengarnock, one at Wishaw. There were also three works at this date in the old Midland iron district. According to Bell, Thomas rails on the North-Eastern Railway were as good as acid rails, and when the first International Rail Pool was formed it sold basic and acid rails at the same price.

[1] The East Midland ores would, of course, have presented difficulties (above, p. 168–9). But so did French and German ores, as there are ample records to show, even though much of the history is, for commercial reasons, obscure. French and German makers used Thomas pig irons with up to 1 per cent silicon before the war —a fact often overlooked in recent discussions (Brügmann, *J.I.S. Inst.* 1902, II, p. 21; *Arbeitsleistung in Stahlwerken* (1927), p. 30; *Aciéries de Longwy*, p. 102. Longwy Thomas pig iron had from 1·6 to 1·8 per cent phosphorus). The elimination of sulphur could have been effected, within the limits of pre-war metallurgical science, between the smelting and converter processes, as at Corby.

Lloyd's, too, put basic and acid-Bessemer steel for a few years on an equal footing.[1]

After 1885 the situation changed. It became more complex, inasmuch as there were now two basic steels—the original Bessemer variety ("Thomas steel", the Germans gratefully called it) and the basic open-hearth variety, which was still experimental in 1885 in Great Britain, though past this stage in France and Germany. Both varieties had a bad name in Britain in the late 'eighties and the 'nineties, but the Thomas steel had incomparably the worse name (though till 1902 it sold in greater quantities, but this was a reflex of prices). The mention of basic-Bessemer, it was said, was like a red rag to a bull to the shipbuilders of the North-East Coast, and the deplorable results of employing it led to the revocation of Lloyd's authorisation.[2] In the early nineteen-hundreds only six railways in Great Britain and the Empire would accept Thomas steel for rails, though tram companies were more receptive.[3] And even tube and sheet makers, who liked the ductility and welding quality of this new metal, turned away from it on account of its unreliability.[4] Basic open-hearth steel had a better official reputation. It was accepted by 1890 both by Lloyd's and the Admiralty.[5] But shipbuilders would not use it; consulting engineers regarded it as unsuitable for bridges, etc.,[6] and it was probably too dear for rails until after 1900.

Jeans, with many others, thought the difficulty in finding consumers for basic steel was due to prejudice, and it is possible that there was much truth in this in the later stages. But there is ample evidence that British basic steel for a considerable time

[1] Cp. article on the work of the North-Eastern Steel Company, *J.I.S. Inst.* 1884, pp. 413 sqq. (and p. 156). Also *I.C.T.R.* Feb. 20, 1885, p. 242 (leader); *R.C. on Trade Depression*, 1886, Qs. 2276–7 (Josiah Smith); *Proc. S. Staffs. Inst.* Report on Annual Excursion, Aug. 22, 1884.

[2] *J.I.S. Inst.* 1889, I, p. 84 (Martell, of Lloyd's).

[3] Information from Dorman Long's.

[4] E.g. *J.I.S. Inst.* 1906, I, pp. 136, 147, and *passim*.

[5] Martell, *loc. cit.* and W. White in *J.I.S. Inst.* 1892, I, pp. 32 sqq.

[6] Cp. e.g. Sir Benjamin Baker in *Proc. Inst. Civil Eng.* 1896, CXXVI, p. 172, who had more anxiety over basic plates in six months than over acid plates in twenty-five years; and *Proc. S. Staffs. Inst.* XVIII, p. 54, where the Board of Trade is implicated.

suffered from serious "diseases", more so than the basic steel of Germany; nor are the sources of this international contrast remote.

At the outset Cleveland's Thomas steel undoubtedly suffered from an excess of sulphur and phosphorus, and there was a tendency to oxidation. In 1907 the manager of Bolckow's was ready to admit retrospectively, on adopting a new mode of working, that these faults had not hitherto been wholly removed.[1] The neighbouring North-Eastern Steelworks was unable in its first ten years to obtain absolutely uniform molten pig to charge into the converter even where melting a mixture in a cupola.[2] British observers often praised the regular and high quality of Thomas pig iron used in Germany in a way which clearly implied a criticism;[3] and some at least of the users of Continental basic Bessemer semi-products found them more uniform and of better welding quality than the British.[4] There was no doubt in 1890 that the Continental basic open-hearth metal was better than the British. Ten Belgian and German firms, but only one British, had made steel to satisfy Lloyd's in 1890.[5] It could be argued that the comparison was misleading, since the Continental material was largely made from scrap, the British mainly from highly phosphoric pig.[6] Lloyd's surveyors regarded the British plan as essentially foolish in attempting to get pure metal from exceptionally impure constituents, and German observers thought the same,[7] and although there were many British managers who emphasised the need for pure and uniform pig iron, others emphasised the goodness of their results by reference to the badness of their raw materials.[8] In a discussion

[1] A. W. Richards, in *J.I.S. Inst.* 1907, I, pp. 104 sqq., a very illuminating article.

[2] Arthur Cooper, describing the new mixer at the North-Eastern works, in *ibid.* 1895.

[3] E.g. Talbot, in *J.I.S. Inst.* 1905, I, p. 130, and Bagley, much later, *ibid.* 1919, I, p. 154.

[4] Private sources.

[5] *J.I.S. Inst.* 1889, I, pp. 85 sqq.

[6] British makers used 70 per cent pig and some ore, Continental makers 70 per cent scrap and little or no ore.

[7] Martell, in *J.I.S. Inst.* 1889, I, pp. 84–6; Thielen, *ibid.* 1887, II, p. 132, and Beck, *op. cit.* v, p. 948.

[8] E.g. *J.I.S. Inst.* 1905, I, p. 140, where a maker boasts of results when using a pig where silicon varies from ½ to 1¼ per cent in a week, sulphur from 0·05 to 0·125 and phosphorus normally is between 2·5 and 3 and sometimes touches 3·25.

before the Iron and Steel Institute in 1892 Snelus, who as a holder of patent rights was an interested party, said frankly that British open-hearth basic steel had still to achieve uniformity of results ("what was needed now was experience").[1] At a very much later date it still was asserted by leading authorities that British makers were behind their Continental rivals in taking precautions to give security in producing basic steel—whether in the converter or the open hearth.[2]

Relative inferiority in British basic steel in these years would not be astonishing. It has been seen that the ores in Cleveland might lead to it—first by presenting special difficulties, second by putting a premium on cost cutting. The Continent was better placed: ores were more phosphoric, less siliceous (on an average), and less sulphurous; and Westphalia had manganiferous ores relatively close at hand. In the second place the British industry suffered through the lack of an adequately trained personnel. There were no doubt individuals handling the new process who were fully as good as the best workers abroad, but they were too few. The Continental tradition of scientific control in the manufacture of pig irons of specific qualities has already been referred to,[3] and would count greatly in the Thomas process. There was one early basic-Bessemer plant in Britain which had its molten pig iron from blast furnaces whose manager could neither read nor write. Another works made open-hearth basic steel experimentally for two years without a chemist: no difficulty was found, the manager said, in making good steel.[4] Such instances are probably unrepresentative, yet may be only a mild caricature of the general position. For the laboratory did not rapidly become an honoured part of the average steelworks, though usually deemed necessary. One critic in the 'nineties describes the normal works' laboratory as

[1] *Ibid.* 1892, I, p. 57. Snelus was arguing that, given experience, British makers *would* achieve uniformity.

[2] *Ibid.* 1919, I, pp. 153–4, 193, 195, and Harbord, in his Presidential Address, 1927. It may be that the outcome of this would not be a lower quality in delivered steel, but a greater proportion of works' scrap: *ibid.* 1927, I, pp. 39 sqq.

[3] Above, p. 5.

[4] *Proc. Cleveland Inst.* 1891, p. 136.

a "pretentious annex", where underpaid and second-rate analysts supplied untrustworthy information.[1] A few years later J. E. Stead, a distinguished chemist closely associated with Bolckow Vaughan's pioneering work, amplified the position.[2] "Members must have noticed in passing through Continental laboratories that the chemists were supplied with books and technical literature upon the points which it was their duty to know." In the works of this country it was not so, and he thought it was very important that English chemists should not be allowed to go on in the rule-of-thumb manner which had been followed in the past. "In some of our works", he added, "the head chemists did not receive £100 per year, and yet they were expected to keep up with the times." About the same date a committee of the British Association, reporting on various methods of analysis, accounted for the inaccuracies of one series of tests by the impossibility of keeping dust out of the laboratory of a famous Sheffield works. At a much later date (in 1911) C. H. Ridsdale announced the success of his efforts to "mechanicalise" laboratory tests in the practice of the North-Eastern Steelworks; apparently he was a pioneer in Britain in introducing methods of analysis which were both rapid and gave results which did not vary with the person of the analyst. Chemists often failed to "adhere absolutely to the details of a method" because it was slow, but by abbreviating it they reduced its value. Until his innovations Ridsdale had been unable to know the composition of pig iron in the mixer prior to its being drawn off for use in the converters[3]—so the significance of his work is clear. This "mechanicalising" of tests appears to have been quite standard in German laboratories before the time when its first appearance in a British works was registered.[4]

[1] B. W. Thwaite, reported in *I.C.T.R.* March 24, 1893.

[2] *J.I.S. Inst.* 1896, I, pp. 117 sqq. [3] *Ibid.* 1911, I, pp. 332 sqq.

[4] A very interesting review of German steelworks' laboratories is given by M. E. Arnon in *Revue de Métallurgie*, 1910, pp. 405–8. It was apparently the universal custom to have each assistant continuously carrying out a single test, i.e. using one method continuously to test for one element only, and to have this testing to control all the routine operations of the works continuously. The chief chemist had a laboratory apart, and was not occupied with routine control, but with the work of research.

Conditions of ore supplies and personnel made it likely that initial distrust of basic steel would be more marked (and better justified) in Britain than on the Continent. The third major influence checking the advance of basic steel in Britain—the location of the consumption of malleable iron and steel—made it particularly hard to remove distrust when it had merely become a prejudice. For it greatly reduced the power of the basic steelmakers to offer their product at low and seductive prices.[1] In Westphalia basic steel bar was normally 5*s.* a ton cheaper than common bar iron after 1890; it is unlikely that this occurred in England, where steel bar was quoted above iron bar in the early nineteen-hundreds.[2]

It has been shown that the basic process was peculiarly adapted to the making of semi-products where a ductile, welding quality of steel was required: for tubes, sheets and wire, for example. These industries had developed first extensively in Staffordshire; but this was an unsatisfactory centre for the export trade, and a migration of these industries towards the coast occurred. They moved west, for the most part: to Lancashire, to Scotland, and to South Wales (where tinplate making, another important consumer of semi-products, was native, a residual or relic of Welsh iron and Cornish tin). There was actually a westward trend as the basic process was being developed. Now this movement placed the industries remote from the most favoured early centre for basic steel—the North-East Coast. To supply South Wales, Lancashire, Scotland and Staffordshire with steel bars and billets involved a fairly heavy transport for Cleveland makers; least in the Welsh trade, but even here 5*s.* or more per ton to the coast (and most works were not quite on the coast).[3] The rail rate to Manchester was almost

[1] This might not be reflected in prices quoted, since in the nineteenth century prices were usually quoted F.O.B. not delivered.

[2] For German prices the sources are given in chapter VII. British quotations are hard to come by for steel bar in early days, and basic bar was rarely separately quoted.

[3] *I.C.T.R.* Jan. 4, 1894, p. 13, shows minimum rates of 6*s.* by sail and 6*s.* 3*d.* by steam to Newport; more to Briton Ferry, etc. *Ibid.* Jan. 30, 1885, p. 143, shows a rate of 5*s.* to Newport.

12*s*. a ton; to Staffordshire probably more.[1] Some local demand for "semis" grew up—Bedson, for instance, an important Lancashire wiremaker, moved into Middlesbrough about 1890—but most of the trade in semi-products was distant. The biggest local trades, railmaking and the production of steel for shipbuilding were, on the other hand, not helpful: the first because it was stationary or shrinking, the second because of a peculiarly potent desire for security buttressed by memories of the difficulty of adapting acid steel to the requirements of the trade.

Other basic steel districts had difficulties of the same category as those which restricted Cleveland. Staffordshire and Sheffield were, of course, better placed than Cleveland for a semi-product trade, but they too were handicapped. The bulk trade had left these districts, and what remained were trades where "brands" were exceptionally important. Tests had never been developed for puddled iron as for steel, and the reputation of a maker did much both to determine the price he obtained and to secure his market.[2] Where purchasers were in the habit of relying on reputation and did not go for the lowest priced among goods of demonstrably equal quality, the advance of a new material was naturally difficult, even where low prices could be offered. There was another difficulty in the smallness of the Staffordshire consumers: for a small firm risked more by experimenting with new material than a large one, and had less resources to risk; and the potential savings of a small firm using steel were sometimes less than those of a big one. It is of interest that Westphalian makers found difficulty over the small consumers—"the small machinist or operator does not seem to be able to get on without his puddled iron"[3]—but the German makers were helped in this difficulty a little at least by the readiness of merchants to sell basic steel bars as iron.[4]

For the most part Continental makers were faced with fewer

[1] *I.C.T.R.* March 13, 1885, p. 335.
[2] Cp. J. W. Hall, in *Proc. S. Staffs. Inst.* XI, p. 102.
[3] *J.I.S. Inst.* 1890, II, p. 527 (Wedding).
[4] *Ibid.* 1887, II, p. 132 (Thielen of Ruhrort). I believe this did not happen appreciably in England, though some English steel bar is at the present time nominally sold as iron.

locational difficulties than the British in overcoming prejudices. They could make bigger price differences between the old and the new products; and their transport problems were slighter. The general lower level of rail costs in itself was significant. Westphalia had an enormous local market, with a big bulk trade where lowness of price was fundamental; and basic steel was readily welcome. There was, for instance, a heavy production of wire, and a considerable tube trade, as the export figures show. Lorraine had a smaller local market, but if her semi-products had to travel to Westphalia or to Belgium or the Netherlands for finishing, it was part of a necessary transit where the ultimate trade was an export trade, not, as with Cleveland, a transit from one good export centre to another which might be less good.

The difficulties of the basic process in England appeared, necessarily, in the districts where basic steel was extensively made. It is seductive to suppose, however, that there was a lack of enterprise shown by the almost complete absence of plants on the East Midland ore beds. There was, it has been seen, no local finishing industry there to encourage experiment in the early days, but with the proving of the new process at home, and still more in Europe, it may be thought the ore resources should have proved adequate incentive to a large endeavour—at Frodingham, for instance, or Corby. No such development actually occurred on a notable scale, though there were the beginnings at Frodingham of what was to become a great enterprise.

The explanation possibly is that these districts were worse off for markets than Cleveland and Staffordshire and Sheffield. They were neither close to a port, nor to any of the consumers of semi-products nor to any great seat of mechanical or structural engineering or hardware manufacture. What they gained on the ore, therefore, they might lose on the trains. The development of such places as Lincolnshire and Northamptonshire was difficult without the growth of some local consuming industries,[1]

[1] Such a development might well be satisfactory for many steel-using industries, since many ultimately distribute their products very widely, and a Birmingham or Sheffield location has no peculiar virtue with regard to markets.

for otherwise it was difficult to make their competition effective, even though they were in a position ultimately to set a new low level of steel prices for England. In the circumstances great capital was required for rapid advance, and the most potent influence would have been capital associated either with a big consuming interest or with an important existing producer of basic steel. For several reasons English economy did not favour a development of this kind. These reasons can be most satisfactorily studied from the history of the industry's structural adaptation to technical and marketing requirements in general rather than in relation to the advance of basic steel viewed in isolation. For since the weakness of the basic steel industry in Britain was not, fundamentally, a reflection of ore resources, it must be regarded as the most notable single instance of the slow adoption of new methods.

Chapter X

BRITAIN AND THE ADVANCE OF THE PROCESSES 1880–1904

No one, not even Lowthian Bell, claimed for Great Britain at the close of Victoria's reign the technical primacy in mass-production steelmaking, irrespective of the "basic" problem, though it was still said by the apologists that there was no indifference to innovation where it was commercially justified. In an unconsciously illuminating remark to the Iron and Steel Institute in 1901 Bell showed how greatly the position had altered since the 'seventies. "At the Clarence Works", he said, "they had done their best to keep themselves up to the American standard: but the cases (on the North-East Coast and in the States) were so different that he had been unable to go to the length of making all the changes recommended." Britain was no longer making the pace. "It must be remembered", he added, in a reference to the prospect of growing imports, "that the amount that might possibly be saved by following the example of the Americans—something like 5*s*. a ton—was more than counteracted by the cost of transporting iron in any form from the United States to this country."[1] The same figure—5*s*. a ton—was given by a witness to the Tariff Commission as the outside limit of cost advantage which German manufacturers enjoyed.[2]

The innovations of the 'eighties and 'nineties which have been incorporated in modern standard practice were pioneered outside Great Britain to a far greater degree than was true of the innovations of the 'seventies. The United States became the acknowledged pioneer in blast-furnace practice, developing along the lines laid down in the 'seventies but harmonising

[1] *J.I.S. Inst.* 1901, I, pp. 123–4.

[2] *Rep. Tariff Comm.* § 680.

them with economy both of fuel (a Chicago feat) and of furnace linings, and crowning the work with mechanical charging, whereby coke and ore for the furnace were filled into buckets or skips from bunkers at ground-level, weighed and carried to the top of the furnace, and then emptied from the buckets and distributed suitably in the stack, wholly by mechanical means controlled by an operator working at the foot of the furnace. Here, said an English steelmaker, was "engineering common sense which amounts almost to genius".[1] Meanwhile French, Belgian and German makers had carried by-product recovery at the coke ovens to success early in the 'eighties, and German and Belgian engineers successfully utilised blast-furnace gas in internal combustion engines ("blast-furnace gas-engines") in the last few years of Victoria's reign. American steelmakers were the first to replace the burdensome hand-charging of open-hearth furnaces by machine work—in the late 'eighties; and they were the first to charge molten iron direct from the blast furnace in Siemens' steelmaking, though British makers made successful independent experiments shortly after. American makers characteristically modified the equipment and layout of open-hearth shops to reduce the amount of crane work, etc., just as they had done with regard to Bessemer shops.[2] Along with the Continental makers the Americans pioneered the use of electricity—and the telephone—in steelworks practice. They also greatly extended mechanical handling and manipulation in rolling mills, and made the chief adaptations of the principle of "continuous rolling", an advance which saved both labour and fuel. Germany also made contributions to mill development of a less striking character concerned largely with important perfections of engineering detail.[3] Against these imposing

[1] J. W. Hall, in *Proc. S. Staffs. Inst.* 1902, p. 32. The phrase also covered mechanical shovelling, and mechanised charging of steel furnaces. The general references for the paragraph will be found later in the chapter.

[2] *Proc. Inst. Civil Eng.* 1896, CXXVI, pp. 138–9, where the subject is well handled and illustrated by diagrams. It is not referred to further in this text.

[3] Some of this was noted by the delegation of 1896. Cp. *Proc. S. Staffs. Inst.* XI, pp. 98 sqq. Kirchoff noted improved lubrication in *Iron Age*, July 12, 1900, p. 2. The most interesting record of the German achievement is by W. H. A. Robertson, *Birmingham Metallurgical Society*, VII, 1918, pp. 9 sqq.

advances the British work in mass-production steelmaking was astonishingly slight; best known perhaps was the introduction of "soaking pits" by Gjers in 1881.[1] There were in all countries many changes that were not given much publicity: alteration, for instance, in the temperature at which steel was cast into ingots, in ingot weights and forms, and in the temperature and speed of rolling. Were these developments known, the achievement of the British industry would be more impressive because the sense of technical stagnation would be removed, but there is no reason to suppose that the picture suggested by the recorded history would appear seriously misleading.

It is simpler to trace priority in invention than the rate at which new methods came into use. The rate of modernising was as certainly less in Great Britain than in the States or on the Continent as the volume of innovation was less, if modernising be measured by the proportion of output handled by modern methods. This in some degree would be a virtually inevitable result of the growing home markets of foreign rivals. But it is almost certain that the conclusion would be true if modernisation were interpreted in a narrower sense to refer to the rate of replacement of old or obsolescent plant. The foreign firms who went in for gas-engines, by-product recovery, electrical cranes, etc., were usually established concerns, and the change was not usually limited to some new section of their plant.[2] Charles Kirchoff, a distinguished member of the staff of *Iron Age*, when engaged on a visit to Europe to discover in all humility what it had to teach America, summarised the situation in Britain with some care and sympathy. There was a mania for everything American—in the whole of Europe but particularly in Britain. "In a discriminating manner (in England) a number of American improvements have been adopted.... What has been done to an extent which is usually underrated has been a remodelling and an extension of older works"; but, "allowing

[1] *J.I.S. Inst.* 1884, p. 467.

[2] E.g. the two first prominent users of gas-engines were Seraing and Hörde; and an early French user was the famous foundry firm of Pont-à-Mousson, who have almost a museum of specimens—the first ones of course discarded.

for palliating circumstances...the cardinal fact does remain that the British iron industry shows ample evidence of stagnation compared with that of the United States and of Germany." The industry seemed "characterised by pessimism and lack of courage"; and though there were some works producing "at very low prices, not far from our best...there does not seem to be that disposition to increase the quantity which we may term 'hors concours'."[1]

British ironmasters did not quarrel with this picture, but pleaded special circumstances. Abroad new plant was needed as demand grew fast: in England "if an ironmaster spent £25,000 to effect a saving he would have to sacrifice the £25,000 he had already laid out".[2] That was the first special circumstance, expounded by Bell. "One wants to be very thoroughly convinced of the superiority of a new method", as another steelmaker—Alfred Baldwin—put it in a curiously familiar style, "before condemning as useless a large plant that has hitherto done good service".[3] There was affection here perhaps, as well as reluctance in "writing off" capital. The second circumstance urged was the comparative lack of security in Britain: with protected prices and the pools which became effective with a tariff "a steelmaker (in Germany and the States) is naturally willing to lay out capital".[4] The third circumstance urged was that for a number of reasons British markets were unsuited to the newer methods: orders were too small, or too varied in character, or too exigent in the matter of quality, for mass-production methods of the American type.

This was an impressive case of half-truths. It was not really plausible to argue that insecurity starved the industry of capital (though it may have had some influence) since much new capital was poured in, particularly when competition was acute. Hugh Bell, with the incisiveness which he inherited along with an obstinate belief in Free Trade from his father, pointed the

[1] *Iron Age*, Aug. 9, 1900, pp. 2–3: the first of a series of valuable articles.
[2] *J.I.S. Inst.* 1901, I, pp. 123–4.
[3] Presidential Address to British Iron Trade Association, reported in *Engineering*, May 6, 1898, p. 569.
[4] *Ibid.*

moral of this investment in a letter to *The Times*, which was occasioned by the support given to Chamberlain by the manager of Ebbw Vale. "Does he not know that within the last year hundreds of thousands of pounds have been spent by British ironmasters in improving their appliances with a view to enlarging their production? Is wisdom only to be found in Ebbw Vale? Are the rest of us idiots to put additional capital into an industry which must perish unless we accept a nostrum of which we totally deny the efficacy?"[1] The steelmakers' apologia was definitely misleading when it suggested that foreign improvements were obtained without "writing off" capital; both in Germany and the States there was far greater readiness to regard relatively young plants as obsolete than in Britain. It could be said fairly that where plants were scrapped they were usually replaced by plants of greater capacity, hence the change might be regarded (with a certain measure of truth) as depending on rapidly expanding markets. But it should have been within the power of well-placed and well-led firms in Britain to grow at the expense of others even where markets grew slowly. No one supposed that all British firms had equally good foundations. Hugh Bell, in the letter quoted above, taunted Ebbw Vale both for its high inland site and for its Board of Directors, led by a solicitor and harbouring a confectioner, who would prove a standby when English steelmakers, through lack of a tariff, had to turn to the jam and pickle trade. It was notorious that the strong firms in the United States had grown either at the expense of the weak or by amalgamation: Carnegie had swallowed up his Homestead and Duquesne neighbours; the Illinois Steel Company was a union of the chief Chicago competitors.[2] These steps were a physical, if not a psychological, possibility in the British industry. By means of them, moreover, it would have been possible, as will be shown later, to remove some, perhaps most, of the handicaps imposed by the character of British orders.

[1] *The Times*, Dec. 3, 1903.

[2] B. J. Hendrick, *Life of Carnegie* (Eng. ed. 1933), pp. 61–2, 330. *Iron Age*, March 21 and May 9, 1899, pp. 438, 691.

Thus the emphasis placed on market influence by the British makers did not account for their slow change of method, but it indicated an important change in the form of the technological problems since the 'seventies. Stationariness of productive methods was often associated now, as it had not been earlier, with stationariness in the structure of the industry. Manifestly the new state might be in part a projection of the same forces as lay at the back of the situation in the 'seventies—individualism, the absence of a keen technological idealism, a desire to put off serious change as long as possible, some lack of courage, and perhaps failings of executive as well as directive personnel. There were, however, other important influences moulding structural development in the industry, and for purposes of analysis it is essential to distinguish between the problems of method which were bound up with the small scale of producing units and those which were not.

The technical changes which most clearly required a growth in the scale of works in Great Britain were the characteristic American advances in blast-furnace design and in rolling mills.

Most of the American innovations in blast-furnace practice either necessitated, or were only justified by, the making of very big outputs from a single furnace.[1] "Hard driving" and large hearths, referred to earlier,[2] both resulted in big outputs, and by 1890 it was admitted in Cleveland that, with suitable furnace "lines", these practices brought fuel economy,[3] With bigger outputs there were also lower labour costs, since much of the work at the furnace was very little heavier for large outputs than for small. Where this was not so Americans devised machinery—not merely for charging, but also for casting pig iron (replacing the labour of making moulds in the sand of the "pig-bed", and of lifting the pigs) and for breaking pigs. The

[1] The literature was very extensive. E.g. Sahlin, in *American Industrial Competition*, 1902, pp. 437 sqq.; Rogerson, *Trans. Glasgow and West of Scotland*, 1900, pp. 153 sqq.; Hawdon, *I.C.T.R.* Jan. 31, 1896, p. 158; Bagley, *Proc. Cleveland Inst.* 1891, pp. 125 sqq.; Billy and Juillet, *Bulletin de la Soc. pour l'Encouragement de l'Industrie*, Jan. 1897, pp. 49 sqq. [2] Above, p. 46.

[3] American furnaces were more cylindrical internally than the British, which bulged out a third of the way up the stack.

machinery for these purposes was substantial because of the weight and heat of the materials handled, and very full occupation was necessary to justify the capital expenditure involved; hence a further effort at increased output, and still harder "blowing". The average output of blast furnaces using coke in Illinois and Pennsylvania rose from 45,000 tons to 90,000 tons between 1890 and 1900, and the most recent furnaces exceeded 200,000 tons a year.[1]

The success of the giants was not at the outset unqualified,[2] but no firm which had embarked on the policy of mechanical charging, the hall-mark of Americanisation after 1895, ever went back to the old system, and the real giants—making 400 tons a day or more—have occupied a continually increasing part of the field. In modern conditions a British firm running old blast furnaces of very moderate capacity (400 tons a week) by the side of American-style furnaces making about 1000 tons a week experiences a saving of 5*s.* a ton in labour cost in the more modern unit, though this is a little offset by increased capital costs. A British plant with hand-charged units of 1100 tons capacity, far more efficient units than the small furnaces of the previous instance, find overall costs are 1*s.* 6*d.* per ton less in mechanically charged furnaces making about 2800 (basic) tons.[3] At the outset the gain would have been less; how much less it is not possible to judge. Probably only one British furnace made 1000 tons of basic pig iron a week in 1900; hence the second

[1] The figures are calculated from data in the *U.S. Census*, 1900. Pennsylvania had a lot of anthracite furnaces which were far less productive. The annual figures represented on an average only 10·16 months' running.

[2] This was true in the States as in Great Britain. Cp. F. Popplewell, *Modern Conditions and Recent Developments in Iron and Steel Production in America* (1900), pp. 70 sqq. It was difficult to distribute the ore well by mechanical means. But hand distribution, it was often forgotten by critics, could be very erratic. Working a 12-hour shift British fillers regularly ceased to charge for hours on end. Nine hours charging by night, 8½ by day, was the regular routine in one works: Clements, *op. cit.* III, p. 115.

[3] The difference is to be accounted for partly by the fact that in enlarging the capacity of a hand-charged furnace from 400 tons to 1000 a big reduction in labour cost occurred: it was said to come to 2*s.* a ton in Cleveland in 1890, *Proc. Cleveland Inst.* 1891, p. 13. It was less than the reduction possible with mechanical charging, since this dispensed with the labour of six men. (This is clear from Bolckow's wage sheets, and is the figure also given for German works: Rabius, *op. cit.* p. 101.)

instance is not "representative".[1] It is of interest that Lowthian Bell thought a net saving of 4*d*. a ton well worth working for.[2]

Advantage was thus to be had by Americanising, and a very large number of British makers gave testimony to this by adopting some minor elements of Transatlantic practice. The pace of change was, however, slow; amazingly slow contrasted with America, but slower also than the German pace. The average output of German furnaces rose from 550 tons a week in 1895 to 850 tons in 1905, when the Westphalian figure was close on 1200 tons. The British average barely reached 550 tons in 1905, while the Cleveland figure was far behind the Westphalian and equalled the Belgian.[3] Before 1900 Thyssen and Hoesch had great furnaces making about 500 tons a day, and in 1900 a Luxemburg furnace was making 250 tons a day from very lean ore.[4] The best British output five years later—not a steady average for the furnace—was 350 tons a day, using hematite ores, at Cardiff.[5] As late as 1922 there were only nine British furnaces which could each produce over 1500 tons a week:[6] and several American-style furnaces of the early nineteen-hundreds barely exceeded an output of 1000 a week.[7]

Within the limits imposed by the "firm" structure of the British industry the situation shown by these figures was unavoidable. Structure was not, it is true, an isolated influence. Giant furnaces were not suitable for all kinds of iron; it is still not satisfactory to use furnaces of over 1000 tons' weekly capacity for foundry iron to sell by fracture,[8] and Cleveland foundry iron was already by 1900 made in hand-charged furnaces approaching this limit. In the States foundries often bought pig iron by analysis, which proved a less exacting sale.[9] Even hematite

[1] Some British makers have improved their hand-charged plant rather than adopt mechanical charging.
[2] *J.I.S. Inst.* 1894, pp. 40 sqq.
[3] Goldstein, *op. cit.* p. 547, and *Census of Production* (for 1906), 1911.
[4] Rabius, *op. cit.* p. 99.
[5] *Proc. Inst. Mech. Eng.* 1905, p. 350.
[6] *J.I.S. Inst.* 1922, I, p. 35.
[7] E.g. at Frodingham and Park Gate.
[8] According to information (1933–4) from Cleveland makers. At Pont-à-Mousson, the great French foundry works, blast-furnace practice implied the same conclusion in 1933.
[9] The decline of fracture sales was noticed in the Census. But even in the States the biggest furnaces were not used for high-grade foundry pig in the early nineteen-

steelmakers' requirements at times provided a check to very big outputs, if a high silicon content were specified.[1] From another angle George Snelus found an obstacle to hard driving in the personalities in the industry—"the men would not be driven, the managers would not be driven, and the furnaces would not be driven, because they had not got the plant and could not get it."[2] The conversation of blast-furnace managers of the oldest (living) generation lends colour to Snelus's remark. But the structural statistics show these to be secondary forces. A mechanically charged furnace was not justified for an output much below 1000 tons a week, and there was little advantage in re-equipping a hand-charged furnace which had a high capacity if output were not to rise. No firm would wish to run with less than two stacks, and more would be needed if several kinds of iron were made. The probable scale of operation of British firms in 1900 is shown in Table XXI, and compared with that of the leading German firms:

Table XXI

Scale of Smelting Firms (1900)

	Number of firms with outputs of				
	300,000 and over	150,000–299,000	100,000–149,000	50,000–99,000	Below 50,000
British[3]	1	8	25	39	50
North-East Coast	*1*	*3*	*6*	*8*	*1*
German (Steel Kartell, 1903)[4]	10	10	3	1	—

Only firms in the first two groups could contemplate furnaces making over 1500 tons a week, and none in the last two divisions was suited to mechanically charged plant unless an enlarged sale were in prospect. Firms in the third group might be able to

hundreds: Popplewell, *op. cit.* p. 85, and *passim*. The big units were at that date more difficult to control for the production of high-grade pig irons.

[1] Paper by Sahlin, *J.I.S. Inst.* 1901, I, pp. 158 sqq.

[2] *Ibid.* 1890, II, p. 51. He refers to an instance where change was possible in an existing scale of production.

[3] Calculated from stacks operated and average district outputs of furnaces, from *Reports* of the B.I.T.A. published quarterly in *I.C.T.R.*

[4] From H. G. Heymann, *Die Gemischten Werke im Deutschen Grosseisengewerbe*, p. 286.

accommodate American furnaces, but the many Cleveland firms in the group already had fairly high-capacity furnaces and made several kinds of iron, and the average in this group in Britain was nearer the lower than the upper limit. The firms best placed for taking benefit from Americanisation were Midland firms with extensive and cheap ore reserves and thriving businesses (often a foundry business) who were working with big groups of feeble furnaces. This was reflected in the location of changes. Cleveland, most progressive in the past, was not outstanding in the new phase of change, albeit its average performance on account of the past remained impressive.[1]

Rolling practice in the States depended for its economy even more than blast-furnace practice on a large scale of operation; for the labour cost involved in handling materials at the outset in the mills was far higher than at the furnaces, and American rolling was characterised mainly by elimination of this manual handling. In view of the variety and distance of movement involved (even with a good layout), as well as the weight and heat of the material dealt with, the mechanical equipment required a more impressively high capital outlay than that at the blast furnace, and fast continuous operation was more than ever essential. Hence rapid cooling and disposal of the finished product was of the essence of American practice, together with rapid pauseless rolling. Three-high mills were popular both for speed and steam saving. In rail and section rolling the number of stands of rolls which could be driven independently and used in series was increased—where two engines were used in England five were used in the States: thus the metal in process of being rolled made a few passes only through each stand, and each stand was continuously occupied.[2] The crowning achievement was the use for a big range of products of the "continuous mill"

[1] Mechanical charging was adopted at the following plants in the early nineteen-hundreds: Bolckow's, Palmers, Cargo Fleet (North-East); Parkgate, Frodingham, Sheepbridge (Midland); Askam (West Coast); and rather later at Stanton and Staveley (Midland).

[2] As in the past it was still frequently remarked that mills of all types in the States were fed with a continuous stream of ingots or billets or blooms when at work, whereas in Britain mills were often short of steel (or short of steam), and men were

—a British invention—in which the hot metal passed through each pair of rolls once only, entering each successive pair immediately on beginning to emerge from its predecessor, so that the metal might (at different points in its length) be passing through eight or ten or more rolls simultaneously. This mode of procedure avoided all such manipulation between "passes" as required any form of power. It being also rapid, greater lengths of blooms or billets could be put through the rolls than heretofore without unduly cooling, which lessened power consumption and wear and tear[1] and minimised the loss involved in subdividing the finished material into short lengths. Finally, output was scarcely affected by the number of passes through which metal was being rolled. This type of mill was devised by Bedson in England in the 'sixties for wire-rod rolling,[2] but it found no welcome: in the 'nineties it was adapted by Morgan in the States to the manufacture of steel rods, bars, and strips ("merchant steel") and of billets.[3] It needed engineering resource of the highest order to devise means both for handling the finished products and for supplying the hot-metal requirements for mills which produced bar or strip at forty or even sixty miles an hour.[4]

often standing about idle. Cp. e.g. J. E. Birch, in *Engineering*, Dec. 16, 1898, p. 775; G. Horsfield, in *J.I.S. Inst.* 1901, I, p. 137. For comprehensive discussions of American rolling cp. esp. *ibid.* pp. 101 sqq., an excellent paper by an American designer, with long discussion; and *Trans. Glasgow and West of Scotland*, 1902–4, pp. 49, 51, etc.; *Proc. Inst. Mech. Eng.* 1895, pp. 436 sqq. (Paper by J. Riley), particularly the discussion, and *Proc. Inst. Civil Eng.* CXXVI, pp. 140 sqq.

[1] The entry of metal into rolls, which became less frequent for a given output, is a strain to a mill, and demands a large effort from the engine.

[2] In the 'sixties a "continuous mill" (*sic*) with four pairs was also made in Wales by While for "roughing" iron rails. Its economies were found in labour saving and in the small loss of heat which occurred during the rolling (*I.C.T.R.* Feb. 11, 1870, p. 90 and *J.I.S. Inst.* 1869, pp. 187 sqq.). Menelaus increased the number of pairs of rolls in the design of a mill for use in France (*ibid. loc. cit.*). Bedson's mill had ten pairs of rolls, and has often been described. While's mill seems to have been forgotten.

[3] Jones and Laughlin appear to have been the pioneer users. They had two continuous "merchant" mills by the mid-'nineties: *I.C.T.R.* May 15, 1896, p. 628. Carnegie followed about this date, and introduced the first billet mill: but continuous billet mills were very uncommon in 1900.

[4] A particularly notable part of the equipment was the Flying Shear, which, moving with the product as it was "squirted" from the rolls, cut it into required lengths. The "continuous reheater furnaces" used by Morgan were based on a Sheffield original.

The output of the American mills was for many products three times that of the best British mills. Five-stand rail mills made 1500 tons a shift in 1900, against the best British output of 500 tons.[1] Good British rod mills made 40 tons a shift (some made only 10); a continuous rod mill made 100 tons or more: on big diameters it might reach 200 tons.[2] In plate mills there was probably little difference of capacity, save in a few instances, but the Americans got the better output through keeping mills more fully occupied with plates near to the maximum capacity of the plant, and they made notable advances (later adopted in England) in cooling plates and in moving them and handling them at the shears and in subsequent manipulation.[3] The number of men employed at the American mills, in spite of the bigger output, was often less than at the British plants. For a continuous rod mill, for example, only eight men per shift were employed directly at heating furnaces, mills, shears and cooling plant; a British plant would have needed over twenty men. A rather bigger maintenance labour staff, because of the mechanical cooling, brought the total labour force on the American mill nearer, but not up to, the British total. For most products American mills probably meant an increase of a few pence per ton of product in capital cost, but it was not serious. In bar rolling, for instance, it was more than offset by the saving in power cost and the greater yield of finished product obtained, the saving in labour cost, amounting to several shillings per ton, being all gain.[4]

Here, as with blast-furnace practice, the British industry, as it was organised in the early nineteen-hundreds, had no room for the giant American units of plant. It is not possible to illustrate this by a survey of the tonnages of specific products—plates, rails, etc.—which the bigger British works made; but the con-

[1] The figures are Lamberton's, *Trans. Glasgow and West of Scotland*, 1903–4, p. 51.

[2] *J.I.S. Inst.* 1901, I, p. 110.

[3] They cooled plates on girders, moved them on rollers and skids, and employed electric cranes for lifting them and clusters of upturned table legs (in steel) with castors on them to support plates and leave them easily movable for cutting, drilling, etc. Cp. Head, *Proc. Inst. Civil Eng.* 1895, CXXVI, pp. 134 sqq. Harbord and Hall, *op. cit.* 1st ed. (1904), p. 410, show the American methods coming into use.

[4] Data have been shown to me by a British firm in support of this.

clusion can be drawn from what is known of the scale of operations of British steelworks undifferentiated according to product. In Table XXII firms which were producers of ingot steel are classified with as much accuracy as the available information allows according to their weekly tonnage of finished or semi-finished products.

Table XXII

Sizes of outputs of firms making finished or
[illegible]

Tons per week: but not over	500 1000	1001 1500	1501 2000	2001 3000	3001 4000	4001 5000	5001 6000
No of firms:	21	12	10	8	5	2	2

This structure gave no scope for rail mills making 15,000 tons a week, billet and plate mills making 6000 tons, strip and rod mills making 1000–2000 tons, particularly since none of the British works were occupied on a single product only. But it indicated a very considerable subdivision of production, whose avoidance might give the necessary scope. From this standpoint, however, the figures are relevant for the heavy steel products only, since the light products—sheets, tinplates, merchant bars, tube-strip, wire-rod, etc.—were made very largely by firms who bought their semi-products, and who were very numerous and, with few exceptions, relatively small. Another table is, therefore, necessary to indicate subdivision of production from a

[1] These figures are liable to considerable error. Two-thirds are based on published figures—e.g. in *Ryland's Directory* and elsewhere—one-third are estimated from information on the scale of plants, such as is given in *Reports of the B.I.T.A.*, e.g. distribution of open-hearth furnaces, in *I.C.T.R. Supplement*, Feb. 12, 1904. The published figures are, in order of the columns in the table, 15, 7, 2, 7, 3, 2, 2. In a few cases the published figures include some finished iron; and several firms used some steel billets which they bought. But a computation of the probable total output of firms as distributed above with the total production of British firms indicates that the figures given err by slightly exaggerating the capacity of firms. Probably most exaggeration occurs with regard to firms making 1500 to 2000 tons, and in this column several of the large Sheffield firms, sparing of publicity, are numbered, perhaps wrongly. The figures are for firms, not works, since in the context these are the relevant figures; but there were only a few instances in which two works or more were held by one firm—one of them occurs in the final column (the South Durham Company).

different aspect, and to allow an estimate of the suitability of American methods for the British market.

The conclusions to which the table opposite points are two. First, that for most products there was scope for a concentration of production into fewer mills, which would not involve any notable increase in the expense of transporting the product to its market. The concentration would not have brought a scale of production equalling that customary in the States, but could have been enough to justify more labour-saving equipment, and to have allowed the distribution of orders so as to get longer runs on uniform products, obviating changes of rolls and other adjustments. Secondly, that for the products where the Americans were using continuous mills, British outputs may not have been large enough in any single district to justify the new-style mills, yet with a new distribution of production, a reduction in the number of districts active, the new mills could have been used. It would, as a South Staffordshire maker put it, have "required a rather large amalgamation"[1] (if it were arrived at by that route), since three merchant steel-rod plants would have done instead of ninety, and a central plant in each industry could probably have supplied all the requirements of steel tube-strip, steel wire-rod, steel bars and tin-plate bars.[2] Would the savings in mill costs have been lost in increased costs of transport? In only one instance is the answer clearly no—tinplate bar consumption was sufficiently concentrated to avoid transport expense (though, as will be seen later, such avoidance here might be purchased expensively). The locational problem with regard to continuous rolling was thus analogous to the problem involved in the opening up of East Midland steel centres.[3]

[1] *Proc. S. Staffs. Inst.* 1902, p. 148.

[2] The picture given here is misleading in one respect, namely, that a mill producing tube-strip may produce "hoops" and "skelp", i.e. strips of steel for other purposes than tubes, such as baling or stamping. Hence the scope for high-output strip mills is greater in both the tube-making districts than the tube-strip consumption figures suggest.

[3] It was not merely a question of analogy. The advantages of moving to a cheap ore site and of concentrating might be combined—but they might also prove competitive. Concentration at an old centre, e.g. Sheffield, might hinder the advance of low-cost sites, e.g. Lincolnshire. These problems are discussed subsequently.

TABLE XXIII

Subdivision of production of certain rolled products in Britain[1]

Product		Date	G.B.	N.E. Coast	N.W. Coast	Scotd.	S. Wales	Sheff. and S. Yorks.	Lincs.	S. Staffs.	S. Lancs.	Rest
Rails (heavy)	Tons (000)	1900	760	147	92	14	148	145	—	2	—	—
		1907	733	—	—	—	—	—	—	—	—	—
	No. of plants	1902	19	2	3	1	5	4	—	2	2	—
		1910	18	4	2	1	4	4	—	1	2	—
Girders	Tons (000)	1907	239	—	—	—	—	—	—	—	—	—
	No. of plants	1902	19	4	1	4	—	3	1	3	—	2
1. Full range		1910	3	2	—	1	—	—	—	—	—	—
2. Light and medium only		1910	5	—	—	1	—	1	1	1	—	1
3. Light only		1910	11	3	1	—	—	3	—	2	1	1
Plates (heavy)	Tons (000)	1907	1355	—	—	—	—	—	—	—	—	—
	No.	1902	20	6	1	9	1	2	—	1	—	—
		1910	18	5	1	8	1	2	—	1	—	—
Bars	Tons (000)	1907	1892 (991)	—	—	—	—	—	—	—	—	—
	No.	1902	143 (86)	16 (13)	2 (2)	22 (12)	7 (5)	23 (20)	1 (1)	45 (15)	10 (6)	17 (12)
		1910	138 (101)	17 (15)	1 (1)	24 (19)	7 (6)	27 (22)	1 (1)	35 (18)	9 (7)	18 (12)
Tubes	Tons (000)	1903	125	—	—	—	—	—	—	—	—	—
	,,	1907	304	—	—	—	—	—	—	—	—	—
	No.	1902	57	2	—	17	1	—	—	37	—	—

The bracketed figures refer either to the tonnage of output which was of steel or to the number of firms which participated in the *steel* bar trade though not necessarily exclusively.

[1] The numbers are based mainly on data in *Ryland's Directory*; the tonnages mainly on the *Census of Production* for 1907. The rail tonnages for 1900 come from the statistics of the *B.I.T.A.*, the tube tonnages for 1903 from the *Rep. Tariff Comm.* Cp. post-war data, below, p. 363.

Several expert observers in the early nineteen-hundreds thought the case for the continuous mill was established; and they could point to the fact that a great number of British rod mills, for instance, were not good of their kind, that the advantage of the new mills was not to be measured simply in terms of this difference between costs in the best old-style mills and the new-style. Even this improper criterion was said to show a net advantage of about 5*s*. a ton for the new plant. In 1906 L. D. Whitehead was to prove by example that those at least who favoured the continuous mill for rods were right; and he did it not in the East Midlands nor in the great bar-using centres, but at Tredegar, with sufficient handicaps in the matter of raw material and transport-to-market costs to make his achievement all the more impressive.

There was another respect—essentially structural—in which British rollers suffered in comparison with American and German and probably most other competitors. The evil of which Bessemer had complained in the rail trade in 1871, the absence of any approach to standard sections, was more serious in Britain than elsewhere in 1900, and affected not merely the rail trade but all section rolling. The result of the "really appalling" number of sections was to necessitate frequent changes of rolls, which was a severe burden, since roll changing and adjustment is often a matter of hours. There is no mode of roll changing which cannot be adapted to mills of low capacity as well as to mills of high capacity;[1] for a given set of orders roll changing need only take the same time on any mill. Hence, although a fast mill will always roll the set of orders in less time than a slow mill, it will also always be idle for a greater proportion of the total time it occupies. Roll changing is thus a more serious check to its productivity than to that of the slower mill, and frequent roll changing will raise capital costs per ton of product more rapidly.

There are signs that the number of rolls used by British makers had grown continuously through the 'nineties, and that

[1] Old mills in fact were less well adapted to fast roll changes than more recent mills, but this is immaterial in considering the bearing of smallness of orders on the use of high-speed mills.

roll changing was at any rate not becoming less frequent. In 1901 the first steps were taken in Britain to improve things; the British Engineering Standards Association was established to design and advocate standard sections, each of which could replace a group of sections commonly made.[1] Benefit was already being felt from the efforts of this committee in 1904.[2] How much the problem affected policy in rolling practice may be inferred from H. J. Skelton's discovery in 1900 that, while English makers produced 122 channel and angle sections in the ordinary run of business, Americans made 33 and Germans 34.[3] The difference was not a matter of luck, but a result of effort: in both instances concerted effort, though in the States the strong firms, like Carnegie's, had done much to favour a relatively small number of sections by differential price policy.[4] Concerted effort had started in Germany as early as 1883, when a complete system of standard sections for rolled iron for shipbuilding, engineering and building had been drawn up under the auspices of the United Societies of German Architects and Engineers.[5] Neighbouring countries followed the same plan. In 1885 a writer in the *Iron and Coal Trades Review* with reference to Belgian success in the girder trade bade the English ironmasters "learn from the enemy, and agree to roll certain standard sections of joists, each one, heavy or light, for which his mill is best adapted, and let him keep these few sections always in stock, so that the merchant may be able to make up a small but varied order at short notice".[6] By 1892 Austrian engineers had officially drawn up a section list of rolled iron and steel.[7] Three years later the work carried on hitherto in the States by individual firms was "collectivised" under the Association of Steel Manufacturers, and users gradually realised they could obtain quicker deliveries

[1] Some reference to its pre-war achievements are given in *R.C. on Coal Industries*, Evidence of Sir Arch. Denny, Q. 95.
[2] *Rep. Tariff Comm.* § 630.
[3] *Amer. Indust. Compet.* p. 255.
[4] *Ibid.*
[5] *J.I.S. Inst.* 1883, p. 825. The technical literature of the 'seventies indicates a much greater study of the virtues of different sections in Germany than in Britain.
[6] *I.C.T.R.* Dec. 24, 1885, p. 889. I have no information indicating the influence of the German standard list, nor the life of the Belgian agreement; but the event was significant, since nothing parallel occurred in Britain (save in the manufacture of cast-iron pipes) till 1900.
[7] *Engineering*, Dec. 30, 1892, p. 826.

and closer competition by using the standards set up.[1] Finally, the Comptoir des Poutrelles was established in France in 1896 and, among other things, set about the work of reducing the variety of sections.[2]

With one exception the notable technological advances which were not bound up with increased scale of productions were concerned mainly with economies in the use of materials. The exception was the supplanting of hand-charging of the open-hearth furnace by mechanical charging, in two forms; first, mechanical charging of cold materials; secondly, the charging of pig iron in its molten state.[3] Material economy was achieved with greatest effect in the manufacture of coke and in the more effective and more diligent use of blast-furnace gases for power supply in the steelworks. The circumstances attending the introduction of these changes form the most illuminating illustration of the continuous operation of the "influences of the 'seventies" in the later age.

The innovations in open-hearth charging derive special interest from the fact that, until close on the end of the nineteenth century, Great Britain made more open-hearth steel than any other country, the output rising from 1·96 million tons in 1890 to 3·16 in 1900. During this period Bessemer steel began to lose ground absolutely in face of its rival, a retrogression usually attributed to zeal for quality, but influenced by other factors: changes in the uses to which steel was put,[4] growing variability in the quality of imported ores which made uniformity more difficult to achieve (particularly in hot-metal working),[5] and the high silicon content of British hematite pig

[1] *J.I.S. Inst.* 1900, I, p. 215.

[2] *La Sidérurgie Française*, 1864–1914, published by the Comité des Forges, p. 521. The Comité publishes interesting results of the standardising work: in 1897 only 12 per cent of I sections and 7 per cent of U sections were "standard", in 1913, 57 per cent and 19 per cent.

[3] The term "mechanical charging" is usually limited to the first, and the custom is for convenience accepted in the rest of the text. The second type of mechanical charging is referred to as "hot-metal charging".

[4] This topic is referred to more fully in chapter XI.

[5] Cp. Whitwell, in Presidential Address, *J.I.S. Inst.* 1901, I, p. 40. There is evidence to suggest a decline in the quality of Bessemer acid rails after the 'seventies. Cp. discussion, *ibid.* 1900, I, pp. 67 sqq. British makers of Bessemer rails did not always deny the irregularity of their product: e.g. David Evans, of Bolckow's, *ibid.* p. 71.

which made fast working on the American plan impossible, etc.[1] The situation naturally gave great scope for experiment in the technique of open-hearth working.

Nevertheless the most important labour-saving economy was pioneered in the States and followed in Germany sooner than in Great Britain. As early as 1888 Wellman at Otis was operating a hydraulically worked machine for charging cold pig and ore and scrap into the Siemens' furnace. The most notable gain was the avoidance of a heavy labour cost; hand-charging accounted for 2*s.* 6*d.* per ton in the cost of steel in the States, and 1*s.* 10½*d.* in England.[2] There was another gain too; a saving of time, which both made it possible to get an additional heat out of a furnace in a week, thus reducing capital costs, and avoided excessive cooling of the furnace roof, which lengthened its life. In 1894 Wellman replaced his hydraulic by an electric charger, finding that the capital outlay was recouped by the increased output of his furnaces, while the labour cost was halved. Three years later Jeremiah Head advocated the plan to the Iron and Steel Institute, and it met with very little adverse comment. James Riley confessed he had "often thought about the problem", but found Wellman's first machine too clumsy, and "suspected the electricity" in the second. "Even if a works had the power, and a skilled man, still there was the question of dust."[3] Windsor Richards, on the other hand, lamented that while Americans were quickly appreciative, "in Great Britain there was always hesitation, owing to fear of the machine breaking down and stopping the works";[4] and another director of Bolckow's, David Evans, had already advised a new Llanelly steelworks to adopt the plan, which he had seen successfully at work in Germany.[5] Eston, curiously enough, changed (in 1905) very late even for

[1] Barrow experience is described *ibid.* p. 304.

[2] The story is told in a paper by J. Head, *ibid.* 1897, I, pp. 89 sqq. Jeremiah Head had intimate contacts with American practice, his son being a director of the Otis Steel Company, which made plates. For the costs, etc., pp. 90, 96. It took 3½ hours to fill a 40-ton furnace by hand.

[3] *Ibid.* p. 104.

[4] *Ibid.* p. 107. Windsor Richards' forcible speech provoked much discussion. Sir Ed. Carbutt supported strongly, especially since "money was so cheap that they didn't know what to do with it". Cp. also J. W. Spencer, p. 108, and E. P. Martin, p. 114.

[5] *Ibid.* p. 111.

England, perhaps through difficulties of layout: Windsor Richards had been moved by the "large space at Homestead" to "wish they could pull down the whole works at Bolckow's and start afresh".[1]

The second innovation in open-hearth charging coincided in Britain with the adoption of mechanical charging, but was indigenous, though it might in fact have been borrowed. In the late 'nineties three British firms—one Scots and two Welsh—began, independently of each other, to use molten pig iron in open-hearth practice. James Riley described his work to the Iron and Steel Institute in 1900.[2] He recalled the intense discussions in the early 'seventies over the use of hot metal in the Bessemer converter. "It is somewhat remarkable that so very little interest has been manifested in the parallel case of the use of fluid metal taken directly from the blast furnace to the open-hearth furnace." Siemens at the Landore works had erected the necessary equipment at the outset, but had not used it successfully: he had more urgent problems. Since that time "statements had occasionally been current that some of our prominent managers had made trials, and for some reason or other not clearly defined had not continued". Two experimenters had, in fact, said that the hearths of their furnaces were rapidly destroyed.[3] While Riley was with the Steel Company of Scotland he had no blast furnaces under his management or near his plants. In 1895 he became manager of one of the two Scottish steelworks where iron and steelmaking were combined, and here persuaded the managers to give a makeshift trial at once to hot-metal working, which succeeded, despite a discouraging "want of confidence in success and the passive resistance often met with in such cases". There was no cutting of the furnace hearth, a big saving of labour at the blast furnace

[1] *J.I.S. Inst.* 1897, I, p. 106. Bolckow's change-over is dated from their wage-rate books. The general scale of working in England was not during the 'nineties too small to make machine-charging an advantage.

[2] *Ibid.* 1900, I, 22 sqq.

[3] *Ibid.* 1889, I, p. 90 (Darby of Brymbo) and *ibid.* 1893, II, p. 17 (Dawson). In the later discussion Windsor Richards and Lowthian Bell both questioned whether the use of molten iron could save any time.

and the steel furnace, a good yield of steel since no sand was charged, and a slight saving of time. He did not mention what later users have uniformly found—an appreciable saving of fuel.

Neither Riley nor the Welsh experimenters found serious difficulty in making this step, and it had been taken successfully almost ten years earlier in the States, though neither introduced into standard practice nor, apparently, boosted.[1] The step was one even more peculiarly suited to the British industry than mechanical charging of cold material; since competitors making open-hearth steel charged little pig iron for a ton of steel, but much scrap (70 per cent), whereas in Britain the percentage of scrap aimed at was 30, and less was usually achieved.[2] There were some works making steel on the pure Siemens' plan, using no scrap at all. The use of molten pig was naturally most valuable where most pig iron was charged. British makers probably stood to gain over a shilling a ton by the practice,[3] and from this standpoint Riley's wonder at the lateness of its adoption was cogent. There was, however, as Riley knew, a hindrance arising from the structure of the industry which differentiated the hot-metal charging problem from the mechanical-charging problem—since a majority of the open-hearth steel firms neither owned nor were close by blast-furnace plants. Twenty-one firms out of seventy-two making open-hearth steel in 1902, with 25 per cent of the British "make", owned adjacent blast furnaces: several other firms were close by independent furnaces.[4] There were enough instances of adjacence and common ownership to give ample scope for experiment, but for many of the biggest plants the change was out of the question. It is of great interest that this structural feature became so marked despite Siemens' prescience at Landore.[5]

[1] *Ibid.* 1900, I, p. 90.

[2] Cp. e.g. Harbord and Hall, *op. cit.* 1st ed. p. 207, and above, p. 176. Riley was using no scrap.

[3] The modern saving is about 2*s.* 6*d.*, but the scrap percentage charged is higher.

[4] The information comes from the sources used above, p. 195.

[5] Below, p. 235.

The problems in coke making, whose solution was an important contribution to cost reduction, had been set in the 'sixties and have been alluded to earlier. Should beehive ovens be used or retort ovens? Should by-products be recovered? Continental makers had favoured retort ovens for well over a decade: by-product recovery was in its infancy. Lowthian Bell, it has been seen, had tried both plans by 1869, and reported retort ovens technically unsatisfactory (producing poor coke), and by-product recovery commercially a failure.

A decade later these problems again became the subject of intense debate in England. At Terre Noire, famous for its mild steel and its steel castings, they had made an acknowledged success of by-product recovery.[1] In 1880 Henry Simon, a Manchester engineer, tried to induce British ironmasters to test the successful Carvès ovens;[2] and a few years later Otto described to the Iron and Steel Institute his rival system, rapidly becoming popular in Germany.[3]

Again Bell's influential voice was raised in opposition. His interest in the innovations had been continuous. "Every time they commenced to build a new batch of ovens at Clarence" the manager of his coking plant "was marched off to the Continent to see what was going on". He always returned hesitant, after the initial failure of the 'sixties. But when a battery of Carvès ovens was put up in Durham, Bell tried the coke in his blast furnaces, and his prejudices were confirmed.[4] He found he must charge two hundredweights more of patent oven coke than of beehive coke to make a ton of pig iron. There was a saving of coal, since the new methods gave a much better yield of coke from a ton of coal; but the blast furnace was more expensive to run and less productive. Here then there was little

[1] *J.I.S. Inst.* 1878, pp. 320 sqq. (paper by Jordan, and discussion) and App. VI, on Terre Noire Works.

[2] *Ibid.* 1880, I, pp. 137 sqq.

[3] *Ibid.* 1884, p. 517. There was also another paper on the Simon Carvès ovens at the same meeting of the Iron and Steel Institute, with a long, useful discussion. The Otto Company advanced capital to build the ovens, which according to J. H. Darby of Brymbo, who preferred Semet-Solway ovens, was the reason for its success. *I.C.T.R.* March 22, 1895.

[4] He wrote a paper on it: *J.I.S. Inst.* 1885, pp. 57 sqq.

economy, and Bell could see no prospect of the accessory recovery plant being a source of profit, since the tar and benzol and ammonia from a ton of coke was worth merely 1*s.* 3*d.* a ton and the working and upkeep of the plant cost 10*d.*—without interest. Bell made his case the more impressive by conducting laboratory tests which supplied a possible scientific explanation of the failure of patent coke.

Bolckow Vaughan's, the pioneer Cleveland ironmakers, supported Bell, on the basis of a little experimenting more than ten years old.[1] But there were other Cleveland ironmasters who were hopeful. In particular Sir Bernhard Samuelson,[2] well known as an advocate of technical education, found that at his Newport works, unlike Bell, he sometimes worked with less patent coke than beehive coke per ton of pig iron and never needed appreciably more. He had, in fact, a notably smaller consumption of patent coke than Bell had of beehive. But he had failed so far—in 1885—to obtain quite as big a product from his furnace or such good quality iron when using the new fuel. His experience was, however, encouraging, and it lent colour to a suggestion of Cochrane's that Bell's work was vitiated by the oldness of his plant—"with a furnace which was imperfect, and not using the full benefit of present-day applications" it was impossible to get the best results.[3] Bell was not using "Cowpers". Samuelson was, and he had a hotter and more powerful blast and a new furnace. There were other vulnerable points in Bell's case; by-product recovery plants were rapidly being made more productive and less expensive to work, and his scientific conclusion was helped by a seriously misplaced decimal point.

[1] E.g. E. Williams, *ibid.* 1880, I, pp. 158–9.

[2] *Ibid.* 1885, pp. 73–5. A paper ten years later by Bell showed how unreliable figures of coke consumption were unless taken for a very long period of time. Within a period of three months the coke consumption at eight Clarence furnaces was studied, and the difference between the highest and lowest weekly average was as high as 5·47 cwt. per ton of iron for one furnace (the one with the oldest lining), only 0·75 cwt. for the most recently lined. The average for the eight furnaces was 2·5 cwt. Bell thought the variation was more when using fire-brick stoves: *ibid.* 1894, II, p. 45.

[3] *Ibid.* 1885, pp. 80–1.

Nevertheless his view, if not his arguments, prevailed, in spite of the great savings which seemed in reach: £50,000 a year for his own firm, he estimated, if Samuelson were right, and £700,000 for Cleveland as a whole. Many cokemakers, it was said, were ready to spend £10,000 to £30,000 on new ovens, but were dissuaded.[1] New-style ovens made little headway in Britain to the close of the century. But in Europe there were great advances; and in 1901 Bell Brothers discovered that at last a satisfactory patent oven had been made by the German Hüssener. They sent him Durham coal, and he made it into coke which appeared in the laboratory to be as good as beehive. So they erected a battery of his ovens at Clarence, with results wholly successful. At least 7 per cent more coke was obtained from a ton of coal, and in their most modern blast furnace the new coke did as good service as the old. The value of by-product recovery was taken for granted.

When the Clarence results were discussed in 1904—at the last meeting of the Iron and Steel Institute which Lowthian Bell attended[2]—no influential voice was raised against them. As early as 1894 David Evans, managing Bolckow's, had said that he found no difference in the blast-furnace value of beehive and patent-oven coke,[3] and in 1904 his firm began installing the new-style oven: within a few years its chairman "doubted whether there is a single colliery making coke in an ordinary beehive oven which is getting its cost price".[4] But while the success at Clarence was not questioned, representatives and users of other types of oven—the Simon Carvès, the German Otto, the Belgian Semet-Solway—gave impressive testimony that the Hüssener ovens were in no way unique, and that others had for some years been at least equally efficient. Samuelson's furnaces and ovens still had better records than the Clarence plant.[5]

The new-style coking which proved economical to the exacting critics at Bell's after 1900 could have been so by the

[1] *J.I.S. Inst.* 1884, p. 533.
[2] *Ibid.* 1904, I, pp. 198 sqq.
[3] *Ibid.* 1894, I, p. 94. Evans in fact favoured the patent-oven coke.
[4] Company Report, *The Times*, Sept. 2, 1908.
[5] *J.I.S. Inst.* 1904, I, p. 198.

middle 'eighties.[1] At that date, when new-style coke sold for the same price as beehive, the expense of the by-product plant was covered by the increased yield of coke; the selling price of the by-products, according to a director of Pease's, being all profit.[2] That the use of the process was so long delayed was due, proximately, to the readiness of blast-furnace owners and managers to accept the results of short and spasmodic experimenting by an authority. There was need in Britain, as Continental observers like Jordan pointed out, for extensive continuous experimental work, since retort ovens were a novelty there and the adaptation of oven sizes to different coals required experience.[3] Moreover since the new coking required greater uniformity in the work of manufacture, it was likely that at the outset the best results would not be achieved consistently, and a short use might mislead.[4] Bell's work of the early 'eighties was only of a few weeks' duration in circumstances which did not allow the testing of the fuel under different conditions of blast pressure and temperature. No lack of capital hindered, nor was there a lack of larger sales to justify expenditure. There was a slight structural obstacle to change. Half British blast-furnace coke was made by collieries selling in the open market,[5] who might be less inclined than combined coal and ironworks to introduce a process which endangered the market value of their product, even though the danger came from prejudice. But this was a minor influence, leaving plenty of potential improvers.

Structure had rather more (though not a dominating) influence on the handling of fuel economy in power supply. The two chief advances in this at the close of the nineteenth century

[1] Though the coke ovens of 1900 were far more efficient than those of 1885. In 1885 the average output of a German patent oven was 483 tons; in 1905 it was 960 tons: Goldstein, *op. cit.* p. 534. But the price of by-products was higher at first.

[2] *J.I.S. Inst.* 1885, I, pp. 85 sqq. The coke, made by a "pure" coal mine, was sold at top prices for foundry cupolas.

[3] *Ibid.* 1878, p. 352.

[4] *Ibid.* 1885, I, pp. 97, 110. Sunday work presented a severe problem in England.

[5] A rough estimate. The position was little different in Germany. In 1880 collieries (presumably "pure") owned 2400 coke ovens; ironworks owned 1700; 1200 were owned by other interests: *ibid.* 1880, II, pp. 592–3.

were related—the use of electrical power in steelworks, and the evolution of an internal combustion engine working with blast-furnace gas. In both of these England lagged behind the Continent and, in using electricity, behind the States as well.

Bedson, the wiremaker, noticed the Continental lead in the use of electrical power as early as 1893.[1] The value of this advance was that the new power could be economically transported. In a large steelworks power was required—often in small amounts and discontinuously—at widely scattered points. Small steam engines were less efficient than big ones, and the carriage of steam through pipes, still more the raising of steam in numberless small boilers in draughty sites, was wasteful. Electrical power could be centrally generated by a big and efficient engine and conveyed and used economically. Dorman Long's began to change over in 1894, and it "answered very satisfactorily": by 1900 they had 150 motors at work.[2] Richard Westgarth's, with an analogous problem in a different industry, saved 50 per cent of their coal bill by displacing scattered steam engines. It was often, in these circumstances, bad steam practice that was to be replaced, not merely steam engines in unsuitable conditions, as Westgarth's manager cogently pointed out.[3] Nevertheless, change came relatively slowly in Britain, and eight years after he had first expounded the virtues of electrical power to the Iron and Steel Institute, Selby Bigge, the pioneer of the change, was trying to account for slow progress to the same body. He thought it might lie in the greater powers of the works' manager to make innovations in America without consulting directors. Moreover "outside England people say, 'What is the saving?' In England the first question is, 'What is the cost?'" Finally, he thought people were making changes when driven by absolute necessity in England, not out of enterprise.[4]

The pioneers of the blast-furnace gas-engine came to the same conclusion. Possibly this mode of using the furnace gas

[1] Coming from Lancashire, Bedson was amazed at the waste of steam in Cleveland. He was a pioneer in using electricity: *Proc. Cleveland Inst.* 1893, p. 96.

[2] *J.I.S. Inst.* 1894, I, pp. 252 sqq. and *Iron Age*, reporting John Panton of Dorman's, Nov. 29, 1900.

[3] *J.I.S. Inst.* 1902, I, p. 276.

[4] *Ibid.* pp. 246–7.

was first conceived in England, by B. W. Thwaite, and it was at the outset thought of in relation to the use of electrical power. Selby Bigge visualised the value of electricity in steelworks for the reasons shown above, and suggested generating the power from steam raised from waste blast-furnace gas: Thwaite showed that a gas engine instead of a steam engine would maximise the supply of power because its thermal efficiency would be much above that of a steam engine.[1] He brought his proposal before Lowthian Bell, soon to be known as the Nestor of metallurgy, with a view to its adoption at Clarence. Probably he had misjudged his man. Bell pounced immediately on the one difficulty: he insisted on first having a clear plan for cleaning the gas. "Mr Thwaite, like many inventors, entertained perhaps too sanguine an opinion of the efficiency of his proposed plan, and so their negotiations as a consequence came to a close."[2] Five years later the thing was passing out of the experimental stage in Belgium and Germany. Gas-engines of high power—up to 700 horse power—had been made and used at Seraing for blowing and for generating power. The Hörde works challenged Cockerill's priority in success, and in Germany at this date (1899) there were twenty-four large gas-engines in ironworks, totalling 12,500 horse power.[3] A year later this figure was 45,000, and there were another 10,000 in Luxemburg. France used as much as Belgium—7500 horse power. Then came Austria, Russia and Italy, with England equalling Spain at the bottom of the list, using 600 horse power. Bell had seen rightly that gas cleaning was crucial, and the Germans had mastered it. It was not, in fact, a new problem for them, since it had long been known that gas was more efficient for any purpose when clean and dry, and they had tackled the cleaning for the benefit of their hot-blast stoves.[4]

Whitwell, President of the Iron and Steel Institute, estimated

[1] *Ibid.* 1894, I, p. 284.

[2] *Ibid.* 1901, I, pp. 65–6 (referring to an incident probably in 1894).

[3] *Rev. Univ. d. Mines*, 1899, III, pp. 1 sqq.; *J.I.S. Inst.* 1900, I, pp. 109 sqq. and 1901, I, pp. 32 sqq. (the figures on p. 76).

[4] Cp. abstract of an important article by D. Kluppel in *Stahl. u. Eisen*; *I.C.T.R.* May 9, 1884, p. 575.

in 1901 that the gas-engine would make an additional power supply of 60,000 horse power available in Cleveland from blast-furnace gas, implying a volume of gas "saved" equivalent to almost 1000 tons of coal a day at least. Virtually it would double the amount of power raised from the blast furnaces. The estimate was not unreasonable, and probably anticipated a fuller utilisation of resources.[1] A few years later a Cardiff engineer pitched the figure a little lower for South Wales, estimating a continuous new supply of 1000 horse power for every 2000 tons of pig iron made in a week (which in terms of coal represented 110 tons of coal or more).[2] To obtain this saving it was necessary to make a bigger initial outlay, since the gas-engine was considerably more expensive than a steam engine, and it was also slightly more expensive to maintain; but it was most unlikely, unless very recent steam plant were being replaced, that increased costs would offset the gain. On the basis of Whitwell's estimate the gain amounted to 1*s.* per ton of pig iron when coal cost 10*s.* per ton. There was a prospect of an appreciable net advantage. And on the Continent, in Westphalia where coal was cheap as well as in the minette district where it was dear, it was realised.[3]

Nevertheless in Great Britain the gas-engine achieved no popularity, and was rarely adopted, even in new works, in the early nineteen-hundreds. Partly this is to be explained by the considerable number of "pure" blast-furnace plants, which had no outlet within the works for additional power. Even furnaces attached to malleable ironworks had little outlet for more power, since puddling furnaces supplied steam to the mills from waste-

[1] *J.I.S. Inst.* 1901, I, p. 32.

[2] On the basis of 1½ lb. of coal for 1 horse power per hour. This was very good practice, and in several industries is not achieved to-day according to the Census of Production: *Proc. Inst. Mech. Eng.* 1906, p. 385.

[3] The Westphalian estimate of net saving was 8*d.* where coal was worth 8*s.* per ton, 1*s.* 10*d.* where 11*s.* per ton. Goldstein, *op. cit.* p. 55. The position was unstable, since while there were constant improvements in the gas-engine there were also improvements in boiler design to use furnace gas. Cp. *Proc. S. Staffs. Inst.* 1906–7, pp. 68–9. J. W. Hall here thought that a gas-engine consumed one-half the gas used by a steam engine of similar power. He also forecast the future importance of the steam turbo-blower "when there is no other use for blast-furnace gas".

heat boilers.[1] For such works the adoption of gas-engines must depend upon the discovery of new demands for power. Probably few works were remote from potential consumers. The demand for electricity was growing; and the co-operation of blast-furnace firms in the setting up of generating stations was mooted in England in 1901.[2] A year later Stinnes and Thyssen had begun the creation of the famous centralised grid system for both electrical and gas supply in Westphalia, a system which utilised the spare power of iron and steelworks for public distribution, creating what was neatly called an "electricity bank", since works could both deliver a surplus and overcome a shortage of power through their connexion with the grid.[3]

It is unlikely that the relative absence of integration in British iron and steelmaking was the most important source of the slight use of gas-engines. Change did not come quickly in combined works, and a lethargic introduction of measures to cut down the fuel bill for power production was no novelty in the industry, occurring where there was no obviously strong structural factor; as, for instance, with regard to electrical power. It was a striking feature of the steam practice of the industry. Compounding of engines, superheating, and the use of central condensing were all used earlier and more fully by rival producers than by British.

The normal explanation of this was that fuel savings were swallowed up "by interest, maintenance, and high wages to a sufficiently trained driver".[4] The third factor was likely to be more important in Britain than on the Continent, since trained men were fewer. Cheese-paring here, moreover, would push maintenance costs up. There is the best possible reason to believe that British steam engines, with refinements, were as good as

[1] This influence was referred to by Samuelson, not using steam as "expansively" as might be in some new plant at Newport: *J.I.S. Inst.* 1887, p. 99. Cp. also *Proc. S. Staffs. Inst.* XIII, pp. 21–2. Steam waste here meant also boiler waste.

[2] *J.I.S. Inst.* 1901, I, p. 4.

[3] The phrase comes from *The Times* (*Engineering Supplement*), Nov. 23, 1910, where the work of Thyssen and Stinnes was well summarised. Cp. Spethmann, *Der Grosswirtschaft an der Ruhr* (1924), pp. 88 sqq.

[4] J. W. Hall, *Proc. S. Staffs. Inst.* 1894–5, pp. 14 sqq.

those used abroad, since many Continental and American makers bought engines in Britain.[1] Possibly a tradition of the undue expense of fuel economy may have been established when coal was exceptionally cheap, and have remained a subconscious irrational influence after coal prices had risen. And the blast-furnace gas-engine more than any steam engine offended the British steelmakers' taste for simple machinery, without "rattletrap" refinements to go wrong: for the high-powered gas-engines even demanded water-cooled piston rods. Hence there was little business for the British engine makers; little chance to remedy faults. For this or other reasons British gas-engines were less good than foreign. The first British firm to have success with a large battery of these engines—the Skinningrove Works—bought them from Seraing, where they made pig iron and steel as well as machines.[2]

In seeking for the source of these technological weaknesses of the British industry which are quite certainly not mainly to be regarded as of structural origin,[3] it is seductive to oppose American advances to Continental as labour-saving advances and fuel-saving advances respectively, and to draw the conclusion that since British wages were below American, and British coal cheaper than much Continental coal, there were adequate explanations here of the location of change. Such a wage and coal situation may have influenced the intensity of effort in some measure. But it is easy to misconceive the position in several ways. Westphalian coal, it has been shown, was little dearer than Durham coal in the early nineteen-hundreds, and nearer to the steelworks. Westphalia may have been moved a little to steam economy by a relative shortage of water; but Cleveland and possibly other districts in Britain felt this problem too (it was, of course, a cost problem), and it is doubtful if differences in water supply are to be regarded as providing an

[1] E.g. cp. *Proc. Cleveland Inst.* 1893, p. 90; De Wendel's obtained a compound condensing reversing rolling engine from Tannett Walker. *J.I.S. Inst.* 1901, I, p. 103: a Galloway engine drove the fastest U.S. blooming mill.

[2] *J.I.S. Inst.* 1919, II, p. 99.

[3] Save in so far as the methods whereby the personnel of the industry were selected may be thought of as structural.

influence of international significance.[1] At Chicago coal was very dear, being far from the mines. An absence of fuel-saving may be due to reasonable neglect, but it may be due to inability or ignorance: and it is fairly clear that the American industry, at least in the early 'nineties, was better endowed with engineers than chemists.[2] There was no chemical industry of the German pattern in pre-war America. Finally it is relevant that in Germany and Belgium labour-saving took greater strides in the 'nineties than in Britain:[3] a fact which, though hazardous to argue from in the absence of exact comparative information concerning the efficiency of labour, presumably implies that British labour costs were high enough to be worth reducing by mechanisation. And this is the conclusion to which most of the particular instances point.

It seems likely that the personal factors traced at the time of the second Paris International Exhibition—the attachment to routine, the lack of adequate training—were still important in Britain at the date of the fourth exhibition, almost a quarter of a century later. It is not possible to prove or measure the first of these influences; it leaves no infallible testimony and can only be inferred from narrative. But the lack of training is in some respects quite tangible.

The relative position of England with regard to technical education had probably changed little since Siemens had analysed its effect in 1879. The position was summed up pithily in 1905—the technical training, which in Britain was done at

[1] Cp. Spethmann, *op. cit.* 1924, pp. 78 sqq.

[2] H. M. Howe made an illuminating remark in 1890: in big steel production "almost no chemical knowledge is required. A good mechanical engineer to build, a good administrator to manage—to select his men with judgement, to treat them with gentle just firmness: who can by appeal now to pride, now to cupidity, identify the interests of men and masters....whose deft velvet-gloved iron fingers can hold a thousand reins", etc.: *J.I.S. Inst.* 1890, II, p. 107.

[3] Cf. *Report of British Iron Trade Association Delegation to Belgium and Germany*, 1896, p. 12: "While we fully recognise the advances made (in economising labour) in the British industry, we were considerably impressed with the general application of mechanical arrangements for relieving labour of its more exhaustive characteristics." American writers were interested in German labour-saving methods, but as far as I have read not in British. E.g. *Iron Age*, July 5, 1900, p. 11: dealing with new Lorraine works.

night schools, was done in Germany and the States in the day.[1] From 1895 the Government made more serious efforts to cope with the problem, and nominally these efforts met with no dissent. But there were many, in fact, who "smiled superciliously when one proposed to associate depression in trade with anything in the nature of incompetence on the part of ourselves".[2] It is possible that this view had so many adherents among employers that the supply of educational facilities and of trained men matched the demand. The nature of this demand in the laboratories of the steel industry has been illustrated in the previous chapter.

Siemens' forecast of the probable influence of inadequate scientific training had of course been in one respect falsified; for he had visualised a continued inferiority in the making of steels adapted to special purposes and a continued supremacy in the mass-production trade. But the reverse position had emerged. Great Britain had obtained a distinguished position as a maker of special steels, the work of Sir Robert Hadfield on manganese steel outstanding.[3] It was in mass-production steelmaking that Great Britain had lost the lead from all standpoints. But the scope for scientific knowledge in solving the problems of mass production had been so great, as the narrative shows, that it would be pedantic to doubt the substantial rightness of Siemens' outlook.

Emphasis has been laid chiefly on the scope for chemical knowledge, and British weakness here has been adequately

[1] Popplewell, *op. cit.* p. 114.

[2] *Trans. Glasgow and West of Scotland*, 1904, p. 6 (R. Lamberton, President).

[3] Bessemer and Siemens steel brought laboratories to Sheffield, and crucible-steel making soon came within the chemist's influence. Despite personal predelictions the discipline of specified tests was accepted, and science was allied to a magnificent tradition of workmanship. Just how the scientific achievement of Sheffield compared with that of French and German makers must be judged by the professionals, if indeed it can be judged at all, for the Sheffield makers certainly, and probably the others too, liked the commercial results of privacy. French work clearly remained important: it included the best early work on alloys of steel and chromium, the development of electrical pyrometry (by Le Chatelier), and the introduction of a mode of compressing liquid ingots which gained more respect than Whitworth's and was for a time adopted by Sheffield. Germany had Krupp. Britain probably could claim no more than parity with Germany, unless by reason of craftsmanship. But this was far above Siemens' forecast.

shown. There was, however, as the "power" problems show, scope for the scientific engineer as well as the chemist, and the British industry was weak here too. In European works it was common to have an engineer with a university training continually present in each of the main shops; one, for instance, "to work in conjunction with the actual operation of the mills". There was nothing of this kind in the British industry, and in many works no member of the engineering staff had a scientific training. Sometimes critics tracked down specific weaknesses to this cause. H. B. Toy attributed to it the slow advance of three-high mills, there being greater difficulties of mill adjustment and roll turning in this sort of plant.[1] But it is an elementary inference that, with the effort after high pressures and speeds, accompanied necessarily by an increase in strains, the "good practical man" stood at a disadvantage.

All the more so since in the British industry plant design was still mainly in the hands of the works' staffs, and much construction was carried out by the big firms in their own workshops. Probably it was the small men, who were not likely to experiment, who were the first extensive purchasers of iron and steelworks' plant from machine makers. From the 'seventies on it was rare for the big works to make their own steam engines, and sometimes they bought cranes—perhaps because of patent rights. Almost all firms bought the "rolls" for their mills; it was a highly specialised trade.[2] Menelaus, manager of Dowlais, gave some insight in 1881 into his practice as a designer. "He made the best guess he could as to the strength there should be, then multiplied by four, and the things never broke."[3] But he was pained at times by the weight of his creations. In the 'eighties specialist machine-making firms, and consultants, took an increasing place in the American industry, but not in the

[1] *Proc. S. Staffs. Inst.* 1900, xv, p. 54.

[2] English chilled-iron rolls were very good, and some were exported to Germany in 1900 (*Iron Age*, July 12, 1900, p. 3). On the other hand Germany made better steel rolls, which England imported.

[3] *J.I.S. Inst.* 1881, I, p. 161. E. Williams was also a great man for weight in engineering products: *ibid.* pp. 162–3. He designed the new Cyfartha steelworks in 1882.

British. In 1896, for instance, Barrow went in for a reconstruction of its Bessemer plant and part of the rail mill, "designed, constructed and carried out entirely by the officials and workmen of the Company: all the plant, including the converters, cranes, ladles, and ingot stripper have been made at the Company's own works".[1] By 1900 there were signs of change. The new coke ovens required consultants: and some blast-furnace improvers called in an American, D. E. Roberts, to advise with regard to mechanical charging.[2] One firm, in lieu of this, appointed an American, Axel Sahlin, to manage its furnaces.[3] Roberts' furnaces were not in all respects at once successful; but a consultant, while valuable for generalising good practice, obviously cannot without local assistance cope fully with the peculiarities of minerals, etc. The same is true with regard to the limitations and advantages of employing specialised machine-making firms.[4]

Before the relatively simple instances of change are left (where scale of production was not a notable influence in determining international disparities), and the intricate forces moulding structural adaptation within the industry are unravelled, there remains one eminently reasonable question to answer. How was it, if absence of scientific training was a potent check to innovation, that Isaac Lowthian Bell, who as the great patriarch of the industry was conspicuous among other things for his university training as a scientist, should have so often discouraged change?

There is no real disharmony here. When Bell addressed the British Association in 1867 he was already 52. Many of the young members of the industry in the early nineteen-hundreds traced its slow adoption of new practice to the power exercised within it by men of advanced years, and it is possible that Bell's

[1] *J.I.S. Inst.* 1901, I, p. 300.

[2] Bolckow's and Frodingham. Also it should be noted that British managers making improvements often visited the States in these years.

[3] Askam. Sahlin soon went to Germany, but later came back as a consultant.

[4] An increasing drawback to making plant at the steelworks itself was the growing requirement of very accurate work, hence of expensive precision plant, which a steelworks could not fully occupy.

negative and defensive reaction to suggestions of change in the period under consideration was largely a product of age. His environment was, moreover, peculiarly favourable to the formation and hardening of an attitude such as his. Early isolation as a scientific ironmaster was likely both to make him unduly self-reliant and to limit his own achievement, to deprive him of the assistance and stimulus of working with a team and in a tradition. There was much fruitless effort after change in England, too, which might induce hesitation even where (as Bell would know) the thing had been badly handled through inadequate knowledge. Finally, his absorption in controversy probably tended to limit his sympathies. Hence, in the period surveyed here, Bell's scientific training was matched against his age and his environment. But it may well be that in early years he had not a notably inventive turn of mind: he did not originate the famous Cleveland improvements in smelting, and came to some of them late and reluctantly; and his valuable chemical investigations, according to his own estimate, justified but did not suggest changes. No training could turn a predominantly critical into a creative mind, and Bell was to all appearances best fitted to be a "governor" in an industry which was inclined to "race". His influence did not indeed derive from any great contribution to technique. Among other ironmasters it probably derived largely from the fact that Bell, with all the prestige of science, and hailing from the most progressive district, so often gave a reasoned basis for their own inclinations, which they could scarcely have given adequately themselves. There was always a lot in what he said, and he said it well. He might be regarded as protector of the unscientific industrialist against the commercially irresponsible inventor; an "expert in experts". Outside the industry his influence derived partly, of course, from his eminence within it, but he had also unusual qualifications to be a link between it and the public. He had been able to establish, as a result of his business and scientific achievement and his personal charm, wide and international contacts, and he was familiar with the chief plants of foreign competitors. His work gave him uncommon insight into com-

parative costs, partly because he was in a position to barter the results of his own investigations. And he collated statistical material, private and published, with a comprehensiveness attempted by no other Victorian business man, in a manner associated now with a well endowed trade society or a "Balfour Committee". Being also a man of some culture, with a commanding presence, Bell made the inevitable and almost perfect witness for a Royal Commission, and an authority for economists. But it is hard to combine with all these accomplishments the part of an improving manufacturer.

Chapter XI

THE PROGRESS OF STRUCTURAL ADAPTATION

1. ENGLISH AND FOREIGN STRUCTURE CONTRASTED

"The British industry", it was said in a brilliant survey of the international position for the *Revue de Métallurgie* in 1904, "was characterised by stagnation." Stagnation, not only of production and foreign trade, but also of structure. Works important in 1904 had all been already important in 1880, and for the most part had grown little since. The commercial organisation of the industry had been unchanged for half a century. Here were the sources of "the excessive division in the means of production" whence flowed all the technological failings of the British industry.[1]

Stagnation was certainly a misnomer for the state of the British structure; because although the character of the structure was little modified between 1890 and 1900, neither the average and maximum sizes nor the interrelations of units changing appreciably, individual components changed much and became more numerous. The pattern varied in detail while its main features were undisturbed. But the contrast of British with rival history was rightly emphasised. It has already been shown, in tracing the advance of productive methods, how British structure was in several directions inimical to the adoption of cost-reducing equipment. It will be seen later that advantages in selling were also obtained by some American and German changes. And though it is not to be supposed that all rival developments were adapted to British circumstances, or even that they all led to economy in their native settings, it is clear that the advantageous modifications, such as horizontal ex-

[1] *Rev. d. Mét.* 1904, pp. 104 sqq.: esp. p. 107.

pansion, integration of pig-iron and steel smelting, were not linked irrevocably with any handicaps. Hence it is a vital and at first a puzzling problem, in analysing the position of the British industry in the early nineteen-hundreds, to account for the absence of radical structural adaptation in the two preceding decades.

There were seven conspicuous contrasts between British and rival development:

1. The rate of growth of big firms without amalgamation was high in rival countries after 1890, low in Britain. In Britain the outputs of the leading works of the late 'eighties—Barrow, Bolckow's, Dowlais, Ebbw Vale, the Steel Company of Scotland[1]—rose inappreciably if at all in the succeeding decade; and though other and, at the outset, smaller firms had a more rapid expansion, none went ahead of these leaders before 1900.[2] In Germany, on the contrary, rapid expansion was common among the firms who were leading in 1890, while the lead was taken by a wholly new one. The average output of German Bessemer plants rose consistently from 109,000 tons in 1890 to 255,000 tons in 1905,[3] during which time no Bessemer plants were eliminated either by amalgamation or successful competition.[4] In the United States it was the same; the biggest ingot producers of 1900 had with one real exception grown in the preceding decade without amalgamation or absorption, and many had grown rapidly and far outstripped the British maxima.[5]

[1] The sources used are those given above, for Table XXII.

[2] Some came very close. South Durham, an amalgamation of three plants, made about 6000 tons a week in 1900. Colville's probably made almost as much as Dowlais (4000 tons)—some of it however was iron; Consett was not far behind.

[3] The full details were:

Date	Number	Average output (tons)
1890	17	109,000
1895	21	
1900	25	175,000
1905	26	255,000

[4] Replacement of old by new plant of course occurred, and there were instances where the new plant was newly located.

[5] The real exception was the National Steel Company. The Federal Steel Company joined the Illinois Company to the Loraine, but Illinois alone raised its capacity from 900,000 tons in 1889 to 1,500,000 in 1898. Carnegie's grew even

In the late 'eighties and in the years after 1900 rising outputs were often achieved by combining, but in ingot production this was not common among very big firms in the 'nineties.

2. New steel plants in Great Britain after 1885 were invariably relatively small at the outset, making 1000 tons a week or less, whereas in Germany and the States they were often big. There were eight new steel plants erected in Germany between 1890 and 1900 which, within a year or so of their inception, made upwards of 3000 tons each a week. All these were erected by firms new to steelmaking (or at least to the heavy steel industry).[1] Krupp's, shortly after 1900, built a similarly extensive new plant at Rheinhausen to replace their common-grade steel department at Essen;[2] but for the most part the older German firms, while they renewed plant freely, did not remove the traces of the older plant and its layout completely enough to achieve the appearance or advantage of complete newness.[3] In the States, on the contrary, most of the big new plants were built by old firms—either as extensions, or replacements on new sites, or replacements on old sites after fairly complete demolition.[4] But there were also a number of big new ingot-making plants set up after 1885 in America by firms new to the trade.

3. As shown in an earlier chapter, only one of the new British steel plants was erected in the area where ores were cheapest and total material costs lowest, whereas a majority of the new German plants were so situated, and in the United States there was a trend—not very marked by 1900, but unmistakable—towards greater concentration of manufacturers on the Lake shores rather than near inland fuel deposits, a trend, that is, towards lower material costs.[5] It is important, however, for the

more impressively. Of smaller companies, Cambria increased its output from 200,000 tons in 1889 to 450,000 tons in 1900; and there are several other instances. The combination movements are traced later in the text.

[1] *Kont. V. u. d. Kartelle*, IV, pp. 561–6.

[2] The new plant is described in *Iron Age*, Feb. 27, 1908, pp. 653 sqq.

[3] Cp. e.g. Kirchoff, *ibid.* June 21, 1900, pp. 15–16.

[4] The classic instance of replacement was the scrapping of the Homestead Bessemer plant in the early 'nineties to set up an open-hearth plant (cp. Trasenster, in *Rev. Univ. d. Mines*, 1897, p. 110).

[5] Pittsburg probably grew more rapidly than Chicago, 1890–1900; but Youngstown and Buffalo grew perhaps proportionately faster.

interpretation of this contrast that development in the district where assembled materials were cheapest in America—in Alabama and Tennessee—was not rapid, and that the district of cheapest ores in Germany, unlike the East Midlands in England, was an old malleable iron district. The pioneer firms in making steel from minette were firms with established iron businesses, to whose continued prosperity steel was a threat.[1]

4. Integration grew more common both in Germany and the States, but rather less so in Great Britain. Four kinds of integration are to be distinguished, and in all there were significant distinctions between British and rival trends.

First, integration in the initial stages, from mining to heavy steel rolling. In Great Britain most of the open-hearth plants were "pure";[2] and this meant that a far smaller proportion of steel was made in 1900 in plants where steel melting and iron smelting were carried on adjacently than in 1880; 45 per cent was the maximum possibility for 1900. There was probably little net change in the extent to which pig-iron makers owned their minerals.[3] In Germany the Thomas steelmakers increasingly used hot pig-iron direct from the blast furnace after the introduction of the mixer in 1889, and integration with iron smelting became vital: it was almost universal by 1900. Unintegrated Siemens' plants remained, but they were often in difficulties.[4] The relation of German steelmakers to their ore supplies had a less simple history, but here too the net result was greater integration. In the 'eighties many Westphalian firms bought up newly valorised Lorraine ore lands; but with advancing use of Swedish ores in the 'nineties, this Westphalian trend to an increased ownership of ore greatly slackened, though there were still occasional purchases.[5] The growing steelmaking of Lorraine

[1] De Wendels in Lorraine, Stumm and Röchling and the Burbach works in the Saar, are cases in point.

[2] Above, p. 203.

[3] Of British pig iron about three-quarters was made by firms who owned part of their mineral supply, and of this a third was made by firms owning both coal and ore. Of pig iron used by integrated firms for steel almost all was made by firms who owned either some ore or some coal: a few owned both.

[4] In 1900 over 75 per cent of German steel could have been made by the "direct" process.

[5] Above, p. 157.

and the Saar was all linked with the ownership of ore: here there was no question of competing supplies. Both in the minette area and in Westphalia the links between steel and coal mining grew more frequent in the 'nineties. Changes in the States were more dramatic and more uniform than in Germany; there was more leeway to make up. Until 1889 the Lake Superior ores were probably all mined by companies not concerned in smelting: by 1900 all the leading Northern steelmakers had acquired ore fields, most of them in the Lake Superior region, though some, favoured by a coastal site, in Cuba.[1] Possibly no firm was from all angles self-sufficing before 1900 in this respect, but many had travelled far towards it. When the Steel Corporation was formed it owned all the types of ore it needed, and it sold to rival makers too. Integration of the well-known steel firms with coal started sooner than with ore. Carnegie absorbed Frick's in 1882. By 1900 most firms probably controlled much of their supply.[2]

In the next stage of integration, between semi-product making and the re-rolling and allied industries (such as tin-plate making), America again provided the most dramatic change. The United States Steel Corporation was, among other things, a fusion of the bulk of the makers of sheets, hoops, tinplates, tube-strip, tubes, wire and common wire products, with the chief semi-product makers; and it followed on a series of smaller-scale integrations. In Germany there was no change of this magnitude, though the largest semi-product maker, the Phoenix works, did in fact unite with the biggest re-rolling firm in 1898, and there had been other fusions earlier—the Bochumer Verein, for example, partly aimed at getting into the finishing trades when it absorbed its neighbour firm in 1889.[3] Integration, however, grew in Germany in the years before 1905 less by fusions than by the setting up of re-rolling mills by the heavy steelworks, in competition with the "pure" re-rollers. By 1900 the "pure" works were notoriously in difficulties due to this

[1] Below, pp. 269–70.

[2] Cp. Willis King, in *Rep. Indust. Comm.* XIII, p. 501, where it is regarded as essential.

[3] Heymann, *op. cit.* p. 153, and Däbritz, *op. cit.* p. 221.

competition; possibly many were eliminated. By 1903 they were numerous in only two of the re-rolling and allied trades—in tube and sheetmaking.[1] In Great Britain the reverse was happening; re-rollers were depending more and more on purchased semi-products—for sheets, wire, tubes, bars, tin plates. Iron semis were still mainly made by those who used them; disintegration in Britain was essentially a feature of steel, not iron re-rolling. In some respects it was rather less than at first sight appeared, since tin-plate makers, ostensibly "disintegrated", were often (and to an increasing degree) participants in the steelworks which made their bars.[2] But the main character of the position was unmistakable.

The third type of integration, of steel rollers with consumers who may be distinguished from re-rollers and the like, as *fabricators*, was probably found at least as often in Great Britain as elsewhere. Measurement is exceptionally hard, because this kind of link may occur in varying degrees of formality. It seems fairly clear, however, that while many British steelmakers were linked with consumers who could absorb part or all of their output, it was more common for older and medium-sized plants to be so linked than for the larger and younger ones; whereas in Germany and the States this was far from being so. Of the ten biggest British steelmelting plants prior to 1898, not one was formally linked with any fabricating concern, nor were there ostensibly important indirect links. Significantly two of the amalgamations at the close of the century changed the picture—Guest Keen and Company was formally, and the South Durham Company informally, integrated with engineering, etc. Among smaller firms links were numerous from an earlier date; indeed

[1] From details in *Gemeinfassliche Darstellung des Eisenhüttenwesens* (1903 ed.). There were 7 "pure" tube works in Westphalia and 9 "combined"; 16 "pure" sheet works and 37 "combined". 4 out of 43 bar works were "pure", and 3 out of 19 wire works. "Combined" works sometimes made only iron semis. In 1900 there were 92 "pure" works in the whole of Germany, consuming 740,000 tons of semis. Combined works who bought some of their semis bought 250,000 tons: *Kont. V. u. d. Kartelle*, III, p. 50.

[2] There were a number of tin-plate works adjacent to steel plants; the indirect links through directorships are hard to trace, but, I am told, were extensive and influential. Cp. below, p. 340, n. 3.

15 per cent or more of the total make of British ingots in 1900 was made by integrated concerns (excluding tin-plate makers).[1] Of these concerns some made high-grade steel only,[2] but many engaged in the more common-grade trades, and of these, it is noteworthy, most were not situated in places obviously suited to low-production costs; the Leeds Forge, for instance, the Patent Shaft and Axle Tree Company at Wednesbury, the Lilleshall Engineering Company at Shifnal and the Butterley Company near Derby.[3] Apart from these links of ingot makers there were also many important "pure" re-rollers[4] who were fabricators—John Lysaght's and Pearson Knowles and the Metropolitan Carriage and Wagon Works are well-known instances; and there were many others,[5] though a comprehensive quantitative estimate of their importance is scarcely possible. Beyond these formal links there were others resulting from interlocking directorates, which were astonishingly extensive in the industry,[6]

[1] The percentage would be larger if firms were included who produced axles, cranks and tyres and springs. These have been regarded rather as having a markedly diversified output.

[2] The Sheffield firms—Vickers', Cammell's, Brown's—were integrated forward, and come into this class. Beardmore's (integrated from 1901) and Armstrong Whitworth's were in an intermediate category.

[3] The list is representative but not exhaustive. Of these four works the first made steel furnaces and wagons, and sold steel plates and forgings; the second made railway wagons and parts and sold steel bars, sections, etc.; the third had a miscellaneous engineering business—tanks, boilers, blast-furnace and coal-mine equipment, and structural work (bridges, etc.); the last was rather similar. All advertised a wide range of rolled products, and had extensive rolling equipment. There were integrated works placed well for the raw-material supplies for some grades of steel, e.g. Armstrong's and Palmer's. But this was exceptional.

[4] Taking "pure" to refer to an absence of "backwards integration" only.

[5] E.g. John Abbots, of Newcastle; Eastwood Swingler, of Derby; Bayliss, Jones and Bayliss, of Wolverhampton, etc.

[6] Of the forty-five chief steelmaking firms (i.e. ingot makers), specialised tin-bar makers being excluded, particulars, incomplete in a few instances, are obtainable for thirty-seven firms. These firms had collectively over 125 links through directors with potential consumers. Only three (including Crewe and Beardmore's) had no contacts. Of twelve firms with one or two contacts, all save three of those for whom information is full carried their work beyond the rolling stage or chiefly made specialities—castings, forgings, etc. Eight firms had 3 contacts, ten had from 4 to 7, four had 10 or more. Of the total, 37 contacts were with railway or tramway companies (18 foreign), 11 with shipbuilding, 10 with structural engineering firms, civil engineers and contractors, 41 with mechanical and marine engineering, 25 with foreign mining companies, 7 with gas or water companies, 7 with petroleum companies. Links with railways might be valued not to sell steel but to reduce

or even from interlocking investments: the total effect of these was almost certainly appreciable. When the British position is compared with that in Germany the impressive fact is that in Germany some of the biggest steel plants were integrated with fabricating plants. Krupp is, of course, the most familiar instance, but not isolated. Of the chief bridge-making firms in Germany in 1900 two were important steelmakers—the Dortmund Union, and Haniel's Gutehoffnungshütte.[1] The Dortmund plant also had a general engineering business. Thyssen, it is well known, was concerned not merely in steelmaking but in many kinds of engineering activity, and his companies were all designed to help each other.[2] The British Iron Trade Association delegates of 1895 regarded this kind of thing as normal; they pointed out, as distinct from British practice, that all the big Continental plants had a first-class engineering department which not only made and repaired their own equipment but also did work for outside customers.[3] In America, too, this kind of integration, which was possibly less extensive than in Britain, was not restricted to the smaller firms; indeed Carnegie's manufacture of skyscrapers and bridges is the most universally familiar instance.

The last type of integration to be observed, concerned with

freight rates. Links with shipbuilding were far more common on the North-East Coast than in Glasgow. Many consumers of steel were themselves interlocked with consumers of their products, which might of course be important for the steel firms, but cannot be traced here. It is not to be assumed that *all* these links were effective, but it is known that some, and likely that many, were. While some modern directors deny passionately that links are ever effective, others speak of them frankly as a mode of rationalisation. The reminiscences of the important company promoter O'Hagan, *Leaves from my Life*, II, pp. 141 sqq., make interesting reading in this context. Contacts with consumers might of course be of value solely by giving an insight into market conditions. The articles of association of companies in early days were sometimes drawn up to forbid interlocking; but by 1900 they almost invariably allowed it specifically, though directors with an outside interest in any proposed contract were not permitted to vote on it.

[1] The Bridge Builders were discussed in *Engineering*, August 10, 1900, pp. 186 sqq.

[2] Thyssen first acquired an engineering works in 1885; by 1905 it was one of the largest in Germany, with a very wide range of heavy products. Cp. A. Tross, *Der Aufbau der Eisen-und eisenverarbeitenden Industrie-Konzerne Deutschlands* (1923), pp. 58–61. He was associated in the early 'nineties with the Löwe group and Thomson-Houston in electrical engineering enterprises, making tramways, etc.: O. Jeidels, *Das Verhältnis der deutschen Grossbanken zur Industrie*, p. 243.

[3] *Report*, p. 13.

the relations of makers and merchants, was not very conspicuous in the early nineteen-hundreds: but there were significant signs of coming change, and again British and rival developments were diverging. Merchants played an important part in the industry since manufacturers had been content, or constrained by want of funds or want of knowledge, to sell a large part of their output indirectly.[1] Many British makers had in various ways set out to make the success of their works of particular interest to a few merchants. A firm would often, for instance, appoint a few merchants in different districts, and sometimes in export centres as special agents, presumably with a financial inducement to push its own rather than competitors' wares, though possibly no important merchant acted in the home market exclusively for one maker of any single product. And merchants were often induced to take shares in steel companies; in several they were made directors.[2] But none of these steps led to a permanent identity of interest between maker and merchant; and it is manifest, though the printed evidence is scanty, that the bigger makers at any rate were anxious to advance the volume of their direct sales, at the expense of the merchants, and through rudimentary selling organisations of their own.[3] In Germany the general position was similar in most respects, but with this vital difference, that the approach of manufacturers to specific merchants led to a far greater identification of interest than in Britain, and only rarely did makers establish a sales organisation of their own.[4] Thyssen was one of

[1] Printed sources on the selling problems of the industry for these years are rare; I have learnt much from makers and merchants directly, and among the latter Mr Gray Buchanan and Mr J. Skelton have been particularly helpful.

[2] The shareholdings may be traced in Company records at Somerset House: the directorships in the *Directory of Directors*, and kindred sources. I have noted twenty-four links.

[3] Direct-sales organisation was most extensive and enterprising in the newer trades, e.g. in the tube trade. It is perhaps a token of the effort to sell directly that several important steel firms did not mention the name of their special agent in London in their entries in *Ryland's Directory*, though the agency can be traced through the entry of the merchant who held it.

[4] The German position is well handled by W. Leisse, *Wandlungen in der Organisation der Eisenindustrie u. des Eisenhandels* (1912), pp. 140–74. The participations of steel firms in merchant concerns, as they had developed since 1900, are given in A. Tross, *op. cit. passim* (firms are treated individually).

the exceptions; but he also became a large participant in existing merchant and shipping concerns, following the more normal course, and he was one of the promoters of horizontal combination among merchants. There were two big German Thomas plants which owed their origin to merchant concerns with which they were largely identified. These were the Völkingen plant, set up by the Röchling family who had an old and far-reaching merchant business based on the Saar coal trade;[1] and the Rombach plant, promoted by Carl Später, a great Cologne merchant, and one of the chief shippers on the Rhine.[2] Another Lorraine firm, De Wendels, had also become intimately linked to a merchant concern by 1900, having Joseph Nother as their sole selling agent. In all these instances the steel plant obtained better control of its selling, could perhaps adopt a more aggressive policy and become more aware of market conditions, more capable of adapting products to users' needs. But this was done by absorbing and utilising (if also in a measure subordinating) existing merchant organisations, not by antagonising them. A similar course was adopted by the Girder Kartell. Most girder sales had been made through merchants. With the establishment of the Kartell, merchants formed a similar organisation; and the makers, far from attempting to sell directly, undertook to sell almost wholly through the merchant Kartell, in whose price-fixing, however, they had a decisive influence.[3]

5. Growth of firms by horizontal amalgamation was far more common in the States than in Great Britain. Even in the American industry only two important instances occurred before 1897. The Illinois Steel Company, formed in 1889, absorbed the three chief Chicago steelmakers (with five works), and became for a few years the biggest American heavy steel firm.[4] The American Steel and Wire Company, formed three years

[1] For Völkingen, in addition to Leisse, see R. Nutzinger (and others), *50 Jahre Röchling, Völkingen* (1931), pp. 8–10.

[2] For Später, Jeidels, *Grossbanken*, p. 264, and Klotzbach, *Der Roheisenverband* (1925), pp. 38, 86, 97, 143 (which also shows the start of Klöckner).

[3] Leisse, pp. 140, 144.

[4] *Iron Age*, 1899, March 21, p. 438, May 9, p. 691, and *passim*.

later by J. W. Gates, was destined by continuous expansion to control most of the wire, barbed wire and wire-rod trade of the States by 1900.[1] From 1897 amalgamations on varying scales and in many branches were common. Those in re-rolling and analogous trades (which were like the wire combine, aiming similarly at monopoly) and the partly derivative union of the Carnegie National and Federal Steel Companies (as related below) were the most impressive; but there were others on a smaller scale.[2] In Great Britain there were no notable amalgamations at all till the late 'nineties, and none comparable with the American examples. Not one of the British combines of heavy steelmakers between 1898 and 1904 created a firm with appreciably more than half the capacity of the Illinois in 1889. Dorman Long's, with three plants, made about 450,000 tons by 1904.[3] Guest, Keen and Nettlefold's, with Crawshay's as a controlled subsidiary, may have slightly exceeded this. The South Durham Company approached the same figure, and unlike the other combines it was devoted mainly to one product —plates, though its production remained subdivided between the three original plants. An associated company, however, was putting up the only wholly new plant on the Tees—at Cargo Fleet. All these amalgamations were important integrations as well as horizontal combines. There was one new company of which this was not to the same extent true. When Stewarts and Menzies of Glasgow linked up with Lloyds of Staffordshire, the resulting company was mainly concerned in making tubes out of strip purchased either from British or foreign makers. The firm made also a mixed output of heavy steel products at Glasgow, but supplied little of its own raw

[1] See Gates' evidence to Stanley Committee, *Iron Age*, June 1, 1911, p. 1311; also *ibid.* Dec. 9, and Dec. 23, 1897, for the final stages.

[2] For the impressive ones, below, pp. 266–8. Among others on a smaller scale there was, e.g., the Central Iron and Steel Company, composed of three Pennsylvanian steel-plate makers; after amalgamating the firm required ores and set up blast furnaces (*Iron Age*, Jan. 4, 1906). The Republic Iron and Steel Company was another, better known, instance (*ibid. loc. cit.*).

[3] For the process and conditions of growth see below, pp. 249, 273. The North-Eastern Steel Company was almost wholly owned by Dorman's after 1904, and is considered as part of the Dorman "concern".

material for tubes; as an amalgamation its importance was that it concentrated a large proportion of the tube trade into the hands of a single firm.[1]

By far the greater part of the British make of steel, light or heavy, was uninfluenced by changes of this kind, and the witness who told the Tariff Commission that "there is not any tendency to amalgamation in the iron and steel industry of this country" was not drawing a misleading picture.[2] And up to the time the Commission began sitting there was even less of a tendency to horizontal amalgamation in Germany than in Britain, for indeed no combine of heavy steelmakers occurred there after 1890 until the Phoenix and the Hörde works combined in 1905.[3]

6. The sixth conspicuous structural contrast was between the elaborate and widespread organisation of terminable associations to control price and output in Germany and the relatively informal and immature development of this sort of thing in Britain; or, for that matter, in the States. In Britain there was no association among heavy steelmakers in the early nineteen-hundreds with so elaborate an organisation as the International Railmakers' Syndicate had had, under German influence, in the 'eighties[4], and associations had invariably proved short-lived. There seems actually to have been less talk of combining (and there was possibly less combination) during the depression of

[1] It was particularly strong in the export market.

[2] *Rep. Tariff Comm.* § 537. The instances of amalgamations nevertheless necessarily take up a lot of space in print.

[3] The Bochumer Verein united with the Stahlindustrie, Bochum in 1889. The total output of this combined firm was 329,389 tons in 1900, not an exceptional figure for a German works: Däbritz, *op. cit.* p. 222, and Table X. For the Phoenix-Hörde union see below, p. 260.

[4] In a leader of the *I.C.T.R.* (July 9, 1886, p. 55) it was stated that the Association had had all orders sent to a central agency, and that a member could not sell direct. Josiah Smith in his evidence to the *R.C. on Industrial Depression*, 1886, Qs. 2272 sqq., showed a position slightly different. Individual firms could take orders directly at prices exceeding the association price by 10*s*. a ton, and this occurred where special requirements had been fulfilled by a particular firm earlier. How effective a fighting weapon the Association might be is shown by the gap between the association price (£4. 15*s*. a ton) and the lower price taken when an outsider was fought (£3. 13*s*. per ton). Smith confessed a long-felt wish to reduce prices by 2*s*. 6*d*., which his fellow associates had resisted. He also indicated the location of the plants which had been unable to compete before the agreement but were now succeeding, viz. Sheffield.

the 'nineties than during the preceding one, when the possibility of a national organisation of smelters was examined by the British Iron Trade Association, and the topic was described rather exuberantly in a trade paper as "the burning question of the hour".[1] After 1900 the earlier interest had revived and was intensified. Both on the Clyde and on the North-East Coast makers of heavy steel products made price conventions locally, and the two groups agreed in 1904 not to invade each other's territories.[2] There was talk of a national association of steelmakers.[3] But no advance had been made structurally beyond the most primitive forms. In Germany it was very different. Organisation had proved extraordinarily difficult to achieve; save in the rail trade no syndicate in any important branch of the industry in 1900 had had a continuous existence of over five years, and there were branches, the bar and wire-rod and sheet manufactures, for example, in which organisation was getting weaker rather than stronger in the opening years of the new decade. But, on the other hand, there were several branches, notably iron smelting and heavy steelmaking, where national Kartells had replaced regional Kartells and the familiar German syndicate structure had ultimately been established. Central selling, which in an elementary form had been introduced into some steel Kartells in the 'eighties, had advanced to its most sophisticated form, in which the selling agency, having become a legal personality, not only had the sole right of selling members' products but could enforce this right by legal action, and in which each maker received out of the total pooled receipts of the syndicate a proportion determined by the tonnage and quality of his deliveries but unrelated to the actual price paid for his particular goods.[4] Until this

[1] *I.C.T.R.* April 23, 1886, p. 598. Cp. *ibid.* Jan. 18, 1884, April 9, 1886 (p. 532) and July 9, 1886 (p. 55). In the depressed years of the 'nineties there were associations in some of the more specialised branches of the industry, but, so far as I know, none in the highly competitive branches. Railmakers started combining obscurely again in 1896, since when association has been continuous.

[2] *I.C.T.R.* Jan. 6, 1905, p. 31.

[3] E.g. *Econ.* Sept. 19, 1903.

[4] Cp. e.g. Kollmann, *Der deutsche Stahlwerksverband* (1905), pp. 8 sqq. and Klotzbach, *Der Roheisenverband*, p. 128.

form of organisation was adopted evasion of agreement was common, and firms who could secure the expression of preference for their products by local users had been in a position to gain appreciably.[1] American development followed British rather than German lines. Pools had been set up in many branches of the trade, and they had often allocated quotas in addition to fixing prices. But they had had no elaborate organisation on the German lines, not even a primitive form of central selling. And they were very discontinuous in operation, periods of devastating price war being recurrent. After 1890 they were illegal under the Sherman Act, and through the influence of the Steel Corporation those with formal organisation and records were dissolved in the early nineteen-hundreds, and their records destroyed. This did not mean, however, that association became in fact less common or effective. The reverse appears more likely; namely, that concerted price-fixing was more consistently successful, though informal, after the dissolution of the pools. Certainly the price wars of the 'eighties and 'nineties were not repeated.

7. Finally, German development, and to a less extent American, was distinguished from British by the greater amount of collective action with objects other than price and output control. One very important aspect of this has been dealt with, the efforts in Germany much earlier than in Britain to cope with the problem of standard sections. Jeremiah Head drew attention to another collective activity which was at any rate potentially important, namely the encouragement of the use of steel for new purposes.[2] The German Iron Trade Association, for instance, undertook collective publicity to further the use of steel in building, and believed it had brought work.

How much of these contrasts can be explained by differences

[1] For obvious reasons English writers have tended to exaggerate the stability of German organisation and the observance of agreements. The reverse aspect has been admirably portrayed with regard to the Pig Iron Syndicate by Klotzbach, a director of Krupp's, who had access to the records of the association. He is able, incidentally, to trace organisation among smelters as far back as the mid-'forties—thus adding two decades to the known history of Kartell organisation in the German industry.

[2] Paper to British Iron Trade Association, in *I.C.T.R.* Nov. 2, 1894, p. 552.

of circumstance and environment, by factors other than the personal attributes of those who controlled the rival industries? British makers often asserted with regard to structural as well as to technological divergence that it was determined by forces outside their control; and it is most fruitful, in studying the structural history, to examine it first from their standpoint.

In doing this it is not possible to discuss the seven contrasts seriatim; for although structural changes may usefully be isolated for analysis, they were in many respects interdependent. This being so, it appears most illuminating to take as the first and main focus of discussion the group of contrasts which had most influence on costs, namely those concerned with the size and location of plants at each main stage of production. In examining the environmental sources of these divergences in horizontal structure, a partial study of the contrasts of integration is inevitably involved. This study is completed in the fourth section of the chapter, the third section being devoted to the development of terminable association. In the fifth section of the chapter the complementary problem is dealt with—the relation of structural adaptation to the quality of the personnel.

2. HORIZONTAL EXPANSION

The first step in accounting for the divergence of British and rival developments, and the easiest, is to explain why in Germany and the States the early leaders in common-grade steelmaking continued to expand appreciably through the 'nineties, while the British leaders did not. Such growth was virtually ruled out for plants in three of the four important British Bessemer centres—Sheffield, South Wales, and on the West Coast—by one or both of two weaknesses, namely deficiencies in raw-material supplies, and remoteness from the markets for steel which expanded as the rail trade shrank.

The ore and coal position has been described earlier. Sheffield was remote from all types of ore; most West Coast plants were remote from coal, their local hematite was less rich and more difficult to mine after 1890, and there were no local basic ores;

the Welsh hill plants, also remote from basic ores, were handicapped by the cost of bringing hematite up from the ports when competition became close, and their imported ores, like the native hematite, had become less rich and less uniform by 1900.

South Wales and the West Coast had an additional raw-material deficiency, both having rather slight local supplies of scrap for use in the open hearth. The history of the scrap market is obscure, but it is clear that steel plants close to machinemaking or shipbuilding or other important consuming industries were best placed to purchase cheaply. The handicap of the Welsh and the West Coast plants in this matter was thus essentially a complement to another more serious weakness, their distance from home consumers of steel. Both districts were, in the early 'eighties, almost solely occupied in railmaking,[1] much of it for export, this being the only purpose for which Bessemer steel had proved an unqualified success (save perhaps in Sheffield). On the West Coast there had been virtually no iron-producing industry prior to Bessemer's invention, and, whether as a cause or an effect of this, no heavy iron-consuming industries had settled in the district; a situation which was little changed by the coming of the new process.[2] In South Wales malleable ironmaking had been long established, but the malleable plants associated with the blast furnaces had become largely specialised on railmaking by the 'sixties, owing to the easy access to the insatiable American market, and no adjacent engineering or hardware consumption was established. Even the tinplate industry, though attracted to the Principality by the pig iron, was some distance from the blast furnaces, for the plants were scattered near Swansea and further West, access to ports and supplies of clean water proving more important than the avoidance of a transport cost on pig iron.[3] When new

[1] Together with fish plates, tie rods and sleepers.

[2] A shipbuilding company was established under the influence of H. W. Schneider, the chief pioneer of the district.

[3] The works bought pig iron and made their own bars. The rate on pig iron was low; lower than the cost of carrying tinplates on the same transit. It was difficult to be near both to a port and to cheap clean water, since for the latter it was de-

iron-using industries began to migrate from the Midlands into South Wales they settled on the coast, just as tinplate making had, and not close to the old blast-furnace centres.

Now because of manufacturing economies, of fuel, labour and equipment, it was almost invariably cheaper to make Bessemer steel where the pig iron was smelted than where the steel was used (or exported). But with open-hearth steel it was otherwise; in the early days to manufacture at the market eliminated freights on finished products, and possibly avoided the transport of scrap, at the cost of carrying pig iron (amounting in Britain to about 70 or 75 per cent of the raw material charged). By 1900 the conversion cost at the market might be higher than near blast furnaces, since hot metal might be charged direct from the blast furnaces and these furnaces might supply power for the steelworks; but these manufacturing economies did not match those in the Bessemer process, and did not necessarily outweigh the transport economies. Hence the distance of the West Coast and South Wales works from new consumers put them at an appreciable disadvantage if they wished to turn increasingly to open-hearth steelmaking when their original product was less in demand. In Sheffield, markets and scrap supplies were more favourable; for by the 'sixties the crucible steel traditions of the district had been utilised by such firms as John Brown's in the creation of a high-grade heavy-steel industry alongside the old light-steel manufactures; hence some engineering was attracted to the district, which was already placed fairly centrally between the chief British engineering districts.[1]

That these circumstances of site value should have checked the rise in the common-grade steel outputs of many of the early British pioneers is thus easily intelligible. In Sheffield the check did not arrest the development of plants, but merely diverted

sirable to be the first plant down a stream. When the plants were being set up, small ships and therefore small ports were in use; hence, perhaps, the westward trend of location in Carmarthen.

[1] Heavy steelmaking in Sheffield began with the manufacture of large crucible steel castings—subsequently forged—the kind of thing in which Krupp had gained the lead by the 'sixties.

development into new channels, the production of steels where costs of manufacture greatly exceeded raw-material cost, and in whose making scrap would be extensively used.[1] But in South Wales and on the West Coast, once the rail trade had passed its zenith, expansion of plants was virtually arrested.

In Germany and the States few of the early firms were beset with difficulties of this kind. If they were, they usually accumulated or acquired funds to allow them to set up new plants in better locations.[2] Dowlais alone of the British Bessemer firms adopted this course, and only in a half-hearted manner.[3] Its partial move was a testimony to the greater cheapness of coastal production, but the owner of the plant—Lord Wimborne—was resolutely opposed to the cessation of steelmaking on the old site, partly through solicitude for the dependent community.[4] If Barrow or Ebbw Vale ever had a mind to move they possibly lacked the funds, since they failed to conserve resources in their hey-day.

Declining site values may explain most of the arrested development of leading British plants in the 'nineties, but not all, since two firms—Bolckow Vaughan's and the Steel Company of Scotland—were immune from this kind of loss. Bolckow's, alone of the great early Bessemer plants, had good access to basic ores and to scrap, and had engineering and shipbuilding close at hand: while the Scots firm, situated where demand and output were expanding, had never been seriously concerned in the shrinking rail trade, and had been a pioneer in the open-hearth process, whose product met with increasing favour. Arrested development in these instances must be accounted for by particular, not general, causes. Bolckow's may, perhaps, be regarded as a

[1] John Brown's was the chief firm concerned. A witness before the *R.C. on Industrial Depression* (1886), Qs. 3265-6, said that "Sheffield manufacturers have no fear about retaining those branches of manufacture upon which skilled labour and years of experience on the part of the workmen are concerned". The making of rails, it was agreed, would go to the coast, though it did so very slowly.

[2] Cp. e.g. Rabius, *op. cit.* pp. 105, 117, for German instances.

[3] Blast furnaces were set up at Cardiff in 1891, and a steel plant later in the decade. But much steelmaking—all the rail rolling, for example—remained at Dowlais.

[4] *I.C.T.R.* July 6, 1900, p. 16.

victim of the goodness of its location, which tempted it to put too many new irons in the fire within a short space of time. The Eston plant first made Bessemer steel in 1875; within five years a new converter plant was being put up for Thomas' process, and a few years later Siemens steel ship-plate making was taken up. Thomas steelmaking was fraught with unexpected difficulties,[1] yet since its product was used mainly for rails it took business from the acid converters, and it is unlikely the firm ever had both its converter sets simultaneously employed fully for any length of time.[2] Perhaps the trade in Thomas "semis", which the North-Eastern Steelworks exploited with success, was unduly neglected; and there are signs that while much money was spent on plant extensions the old equipment was not quickly enough replaced.[3] The Steel Company of Scotland was never faced with Bolckow's complex problems, and could approach single-minded the making of Siemens steel, mainly for ships. But it had one tangible weakness, since its work was divided between two plants; a course which may have been determined by the limited acreage of the first site. James Riley, the famous first manager of this firm, who built up its trade and reputation, thought its directors failed to change their plate mills in the mid-'nineties when it was—in his view—necessary.[4]

If there were good reasons why the early leading plants of the British industry often ceased to expand, why were their outputs not surpassed by new firms—the products either of rapid individual growth or of amalgamation—in districts suited to

[1] Above, p. 173. The ship-plate making also presented difficulties. Cp. *J.I.S. Inst.* 1886, I, pp. 113–14, where Windsor Richards discusses the difficulties of getting wide plates of equable quality. A few years later Windsor Richards gave some record of Bolckow's experiments with open-hearth furnaces of various designs—round and oval as well as rectangular—which also help to show the complexity of the firm's problems: *ibid.* 1889, I, p. 105.

[2] This is the impression gained from the wage records used for chapter VIII.

[3] Above, p. 129. Live roller equipment was less extensive at Bolckow's than at the North-Eastern Steelworks in 1893, though the Eston plant was by far the more productive. Soaking pits were only installed in 1893, when the patent expired. Neglect of the "semi" trade may have been due to a desire not to set up a new mill; rolling capacity may have been much less than melting capacity.

[4] *J.I.S. Inst.* 1908, I, p. 45. Riley brought in a 3-high mill, but it was dropped before being perfected.

expansion by their cheap and extensive ore resources, their ample markets or their scrap supply?

Technological features of the open-hearth process contributed to this, as they did to the check of the older firms, since the Siemens process was more tolerant than the Bessemer process of relatively small-scale as well as of unintegrated working. This arose from two sources. First, the comparative slowness of the process. It took about half an hour to make a "blow" of Bessemer steel, twelve hours to make steel in the open hearth. Until giant open-hearth furnaces could be made, the output of a unit in the new process was necessarily far lower than in the old. In the early nineteen-hundreds the biggest Siemens furnaces averaged little more than 400 tons a week; the up-to-date converters at Barrow in 1896 made 1500 tons each, and even by 1880 the best British converters made over 600 tons.[1] It was, it is true, advantageous to group together a larger number of open-hearth units than of converters, because only thus could a regular flow of ingots be obtained in the slower process; but, until furnaces were very large, the influence of this factor could by no means counterbalance that of the former. Second, the relative absence of machinery in the process. The Bessemer process from the outset required a very elaborate and expensive mechanical plant for charging, tapping, blowing and dismantling the converter, hence capital costs were heavy unless outputs were high; and moreover, since the labour force required scarcely varied with capacity, capital and labour cost were both greatly reduced in high-capacity plants. Economies from high capacity were much less in the Siemens process, which, being less mechanical, involved a capital outlay varying far more closely with the scale of output,[2] but which also by the

[1] The average output for all British converters in 1879 was 12,000 tons a year; the open-hearth average for 1882 was below 3000 tons. The open-hearth average for 1904 was about 6000 tons, much below the figures for the big furnaces making over 400 tons per week. One Talbot furnace of 1906 reached 1350 tons, but was quite exceptional. Cp. *J.I.S. Inst.* 1880, p. 243; *Rep. B.I.T.A.* 1882, p. 425. For 1904, *I.C.T.R.* For 1906 detailed information for thirteen of the biggest firms is included in an unpublished Arbitration Award.

[2] A great part of the outlay was on brickwork, which became progressively less per ton of capacity as furnaces were larger, but slowly.

same token gave less scope for reduction of labour cost. Until the introduction of mechanical charging and hot-metal charging, labour cost per ton scarcely varied with increases in the size of furnaces.[1] Small and large furnaces were often run side by side for very long periods, which suggests that the margin in costs was slight; that though savings were enough to justify largeness in new furnaces when this was compatible with quality, they were not enough to justify replacing old ones.[2]

Thus in the early days of Siemens steel the establishment of small steel plants, wherever steel of this quality was wanted, was definitely favoured; a start could be made with a small capital outlay, and the bigger malleable ironmakers, where their puddling business was threatened, could with little expense turn to the new business, utilise their old rolling plant, and market steel with the goodwill established in the iron business.[3] It was the same in all countries; Herr Thielen of Westphalia, for instance, complained of it in 1887: "these mild Siemens plants were springing up everywhere in the most out of the way places, to the detriment of the steelworks", i.e. of the Thomas plants.[4] It was, however, more important for Great Britain, where, it has been seen, converter steelmaking declined after 1890 and the open-hearth process for a variety of reasons made proportionately far more headway than elsewhere—because of the greater importance of engineering and shipbuilding industries as users of steel, the greater exigence of British consumers in general, the unsuitability of many British ores for the converter processes, and some lack of skill in handling these processes.[5]

[1] There was a lower maintenance labour cost for large tonnages, because of the smaller volume of brickwork per ton to be repaired. The position was accentuated by the rigid system of piece wages.

[2] Relative smallness in the outputs of open-hearth furnaces not only allowed small-scale plants, but meant also that gradual growth would be more economical in a Siemens plant than in a Bessemer.

[3] Of the 11 big Scots steel plants of 1890, 9 had first been malleable iron works; 9 out of 12 on the North-East Coast had the same origin; 5 out of 7 in Staffordshire and Shropshire.

[4] *J.I.S. Inst.* 1887, II, p. 132. In 1900 most German and American open-hearth plants were still small; if the Homestead plant be left out of account the average new plant of each country (and particularly Germany) was considerably smaller than the British.

[5] Above, p. 200.

Here then is a key to the frequency of the establishment of new small steelmelting plants in Britain, and of its greater importance there than elsewhere. But the persistence of small plants and the relatively slow emergence from among them of high-capacity plants is less simply explained, though it is true that the relatively small capacity of open-hearth units allowed economically more gradual growth than with the Bessemer process. Yet by the mid-'nineties the cost advantage enjoyed by big producers of open-hearth steel was manifestly growing, and the cost advantages of high-capacity rolling mills for heavy products had already become of great value.[1] Why had no British firm in the early nineteen-hundreds set out successfully to obtain these advantages to the full?

In answering this question a vital distinction between British and rival conditions must be borne in mind. Great new plants could emerge in Germany and the States without other plants being stationary, let alone shrinking or disappearing; in Britain that was possible to a very limited degree, if possible at all. Lower costs could have added a little to the British trade, but German and American makers had far larger and more expansive home markets than the British, and advantages both at home and abroad by reason of their tariffs; moreover, the world export trade, in which the British industry was particularly interested, was being increasingly disturbed by fiscal policies. These were the fundamental bases of the greater size and expansion of output in Germany and America. Now this expansion was also concentrated in far fewer centres than in Britain, where steelmaking was amazingly scattered. In this it reflected primarily the scattered disposition of British ores; though, since none of the ores was situated directly on the coast, many makers of malleable iron, and steelmakers following them, when their main trade was for export or for shipbuilding, had settled on the coast away from the ores. Since the local market for a steel producer necessarily enjoys a considerable protection by reason of transport costs, the greater the subdivision of production, the greater are the obstacles to the rise

[1] Above, ch. x.

of high-capacity plants so long as production and use occur frequently side by side. Furthermore in Great Britain, where subdivision was greatest, and expansion of production least, railway rates were highest; and—although the district outputs and consumption of specific steel products are not accurately known, and would have slightly varied with variations of production costs—it is virtually certain that except in the East Midlands and possibly on the Clyde no great steel plant could have emerged in the 'nineties save by lessening absolutely the trade of some rival producers, or as a result of amalgamation.[1]

The significance of this distinction between market circumstances in Britain and in rival countries as environments for plant expansion is in some degree immediately obvious; it is always likely to be easier, in any trade, to obtain the custom of new consumers than to take custom from old producers, partly because there will be no established personal links to break, partly because the old producers will be less disturbed. But the problem was of peculiar importance in the iron and steel industry because there were features in its constitution which made established (albeit high-cost) producers peculiarly able to resist elimination. These features were the durability of iron-working equipment, the fact that the processes lent themselves to diversification of output and to the production of specialities and common-grade products with the same equipment, and the fact that production was often, as shown above, "integrated" with consumption. In view of the strength of these forces, which will shortly be examined, if there were to be rapid plant expansion in Great Britain either more expenditure or more skill would have to be forthcoming than in rival countries. And here the British industry suffered from another disparity, less satisfactory access than its rivals had to capital

[1] The statistics collected by the British Iron Trade Association and given in chapter x are some help in this. It is not to be assumed of course that growth of markets in one region could never be the chief basis of plant expansion in another: but for this to occur the cost advantages of an expanding plant through mineral resources would need to be great (as in the East Midlands), unless there were exceptional disparities of skill, enterprise, etc.

resources, and a less efficient financial mechanism for handling amalgamation.

The first foundation of the resistance to elimination, durability without expensive running repairs, was probably particularly characteristic of old-style equipment, which involved much manual handling, and was not run at great speeds or subjected to such exacting strains as more modern plant. The Dowlais Company used until 1906 a mill engine which was then seventy-five years old; most Scots blast-furnace blowing engines were forty years old or more in the 'nineties, and there are still in use rolling mills dating back to the 'eighties or earlier. This durability meant that a "high-cost" plant might remain active in the industry—perhaps discontinuously—for a very long time, if prices, though not high enough to allow the accumulation of funds for replacement, were at least spasmodically above the prime costs of production.

The second and most important foundation of the great resistance of established firms to elimination drew its strength from the unequal intensity and effectiveness of competition at any particular time in different branches of the steel trade. An open-hearth melting shop could supply steel at one and the same time for plate, section, bar, and strip mills, for a forge and for a foundry; a section mill could roll rails, girders, and angles for ships, from steels of different quality and in sections requiring varying degrees of rolling skill; and so with other units of plant. Until very recently it has been an almost universal characteristic of firms to utilise this adaptability, and to increase the variety of their productions with advancing age. This step might be taken for more reasons than one; but it usually implied either that the existing trades of a firm were becoming less satisfactory, by reason of shrinking or fluctuating demand or growing competition, or that while existing trades were profitable others offered the prospect of being more so, and hence were a greater attraction for new investment. In either case the new product, from the cost accountant's standpoint, would be more profitable than the old.

The duration of the advantage derived from this step de-

pended upon the source of the higher rate of profit in the new or newly-pushed "line". When there was merely a shortage of equipment, but the technique involved was common property and skill could be readily acquired, the duration might well be short. Where steel of a refined quality was wanted for exacting and responsible uses; where faults were unlikely to show in fabrication, but only in service; where consumers had a "name" to preserve, or had a workshop routine adapted to the use of a particular brand of steel, or had clients anxious for rapid delivery, which could not be given if there were faulty raw material; where a demand for a speciality was small or local, too small perhaps to encourage or even to catch the eye of potential competitors; or, finally, where large initial capital expenditure was required for an erratic and limited market; in cases such as these the reputation or contacts of a steelmaker once established were likely to be effective for a long period, during which he might retain his relatively high rate of profit on the products concerned. Even in railmaking, reputation might help a firm; it was more important for bridge steel and for boiler plates, and still more for high-grade engineering steels, and forgings and castings.

Where circumstances thus permitted a relatively high rate of profit on any product, the maker of the product was as a result in a good position for engaging in more competitive trades, when this was necessary to keep his plant busy. For to the extent that he more than covered average long-period costs in the high-profit trade, he could sell persistently, if need be, below this average in other trades. When demand for the high-profit product rose, the power of a firm persistently to dump other products would rise also. Hence factors, which by limiting the penetrability of some trades limited therein the scope for large-scale methods, also threatened other more common-grade trades with a chronic instability, which would be inimical in them too to mass production, unless the dumping firm itself were attracted to mass production and in a sufficiently strong position to carry it out. In an old-established industry like the British, where home-market expansion had ceased to be sensational and where

the contacts and reputations were mostly enjoyed by firms whose mineral basis was either weak or weakening, the situation was peculiarly unfavourable both for the rapid rise of new firms, lacking contacts and reputations, and for the rapid growth of old ones.[1]

The influence of diversification on price policy was not often discussed publicly by steelmakers. But the nature of this influence was not left wholly to the imagination, being referred to by several witnesses before the Tariff Commission, who, in expounding the reasonable basis of German and American dumping, made no secret of their own readiness to sell part of their product "below cost", and indicated that profits varied much from product to product. A wiremaker, for instance, remarked that "it was the common classes of wire which have become specially unremunerative"; competition in the mattress-wire trade had been successfully met, "but the price is very bad". A Sheffield witness, C. W. Kayser, agreed that "to keep workmen employed" he took "orders which were not remunerative": and added that "certain qualities in particular" were brought down in price by competition: the cheaper-grade goods, not the higher class. Another witness, who shared his energies between the affairs of a Welsh and those of a Sheffield firm, held that "Sheffield is living to a great extent on its reputation for the production of high-class steels: in such cases prices are not a material consideration. A customer...is prepared to pay more rather than break his connexion." But in some articles com-

[1] There is no means of measuring and expressing the extent of diversification of output, of showing whether it was more or less common in Great Britain than elsewhere. But it was sufficiently widespread in Britain for the comparison to be of little moment. Apart from the Welsh tinplate bar makers there were no steel-melting and rolling plants wholly specialised on a single product. The specialised rail rollers of Wales had closed down. Of re-rollers there were few who did not combine strip, rod and section rolling, and most had several mills. A considerable number of steelmelting firms made forgings and castings as well as rolled products—axles, cranks, wheels, stern frames for ships, etc.—or made highly specialised rolled products, such as tyres and springs. Others again made special sections—*Ryland's Directory* teems with these—or undertook cold rolling as well as hot. Most firms also emphasised their "brand" marks; and though these were more important in malleable ironmaking than in steel, save for the commonest products they still retained some significance; steelmaking had not become wholly automatic, and quality depended partly on the skill and watchfulness of the makers. This indeed still remains true, and in any country there are still better and worse makers.

petition was in fact being felt, for example "the mining industries of South Africa are becoming more familiar with the art of purchasing steel than they were". Another witness, a Midland steelmaker, found that the "expensive sections" which he rolled —channels, girders, and sections for railway wagons—now gave him less profit "because we cannot get orders for the rougher or cruder materials to help out the more expensive". Finally, Sir Thomas Wrightson told how the North-Eastern Steel Company found that semi-product prices did not pay, and had gone into a "higher class of manufacture" to obtain profits; yet still made semis "at a price much below cost", albeit "as little as we can, only we should lose more if we allowed our mills not to get this help to get through their quantity".[1] All these witnesses save C. W. Kayser ostensibly had in mind foreign competition alone; but their mode of competition against home and foreign rivals would be substantially the same; and it is manifest that diversification, whether or no designed to give the special kinds of competitive strength which has been delineated, did in fact give them, and by doing so presumably hindered the growth of plant outputs and the erection of new plants.

Integration of producers with consumers, the extent of which has been already suggested, had effects analogous to those of diversification, the making of specialities and the building up of goodwill. A steel plant which had a secured outlet for part or all of its make would be in a very strong position whatever its production costs if the finishing branch of the concern was occupied in an industry in which competition was not close, or where the cost of the steel was only a minor part in the cost of the finished product. An extreme instance of this occurred where a railway company possessed its own steelworks, as the L.N.W.R. did at Crewe. At the outset this particular integration was part of a far-sighted policy of using steel, and valuable pioneer work resulted. Later the plant had relatively high prime costs,[2] in part no doubt because the consumption of a

[1] *Rep. Tariff Comm.* §§ 907, 911, 743, 643, 650, 728, 578–9.

[2] It may have had almost from the outset, since there were never blast furnaces at Crewe.

single railway did not warrant the equipment which, fully employed, had the lowest costs;[1] but no competitor could count on driving the plant out of business. Few integrated consumers could be so inaccessible as this; but there were lesser yet still potentially important degrees of security, derived from reputation, the production of specialities, local monopoly, and the largeness of capital outlay needed to initiate competition. Nettlefold's provides an illustration of this.[2] Linked with a consumer thus protected, a steel plant could be sure of disposing of a proportion of its product at a transfer price fully covering long-period costs, and might be enabled thereby to sell advantageously some or all of the rest if need be at prices below "total costs".

The structural outcome of this was not uniform. Integration, so readily conceived as "rationalisation", may well become an unhealthy condition, a sort of stiffening of the joints of industry. Carnegie was probably the more able to extend his rail trade because he built skyscrapers and bridges. But if, as happened often in Britain, the integrated steelworks was not well situated, as Carnegie was, to make fairly cheap steel, the more likely consequence—inconspicuous because not positive—was that the adoption of high-capacity plant by other makers, either in the same locality or elsewhere, even though they had much better access to minerals, would be discouraged.[3] Carnegie indeed enjoyed the use of a number of competitive weapons in combination which in Great Britain were distributed among opposing firms.

Possibly in addition to the kinds of strength delineated above there was another enjoyed by small firms in competition with larger ones precisely because they were small, namely that small

[1] A variety of factors would contribute to this; in the case of rails distance of delivery as well as limited demand would count. Many products would be required spasmodically in large quantities. It was not only in steelmaking that an integrated plant such as Crewe might be a high-cost producer. Cp. American criticisms with regard to locomotive production.

[2] Their strength derived from the first two and the fourth of the sources listed. They were, as events proved, more vulnerable to foreign than to British attack, and the foreign attack did not derive its strength from integration with cheap steelmaking.

[3] It might indeed well happen that an integrated plant was a hindrance to the use of more efficient plants, though its own plant was as efficient as any in use.

consumers and merchants preferred dealing with small producers. The small consumer's order "counted" more when he bought off a relatively small producer: he felt more secure of consideration. And the merchant was anxious to put off as long as possible the advance of makers with semi-monopolistic strength. For many products merchants had their own brands, with a reputation, which no doubt gave tactical strength.[1]

Everything which added to the difficulties with which a new high-capacity plant would be faced in dislodging competitors marked out amalgamation as the route to low-cost production.[2] Yet the obstacles to the elimination of competitors also proved to be obstacles to effective amalgamation, since they tended either to raise its cost or to put a premium on individualism.

During the American amalgamations of the late 'nineties it was observed in *Iron Age* that "prices must be paid for plant out of all proportion to the cost at which it could be duplicated, because a concern is measured by its capacity to inflict damage to prices".[3] Later a steelmaker related to the Supreme Court how in these years, having concluded a very profitable sale of his plant to the National Steel Company, he had acquired other interests in order "to shake the apple tree again".[4] Where this occurred, and particularly if an amalgamation had been largely financed by bonds, cumulative preference shares, debentures, or the like, interest payments might provide a severe initial

[1] The evidence which I have bearing specifically on this is mainly verbal. The antagonism of merchants and makers is well known, but the form in which the complaint is usually put is that merchants "play one maker off against the other": see below, pp. 294, 381. Often possibly the small maker did give more consideration to the small user than large firms; it was apparently so in the States (*Rep. Indust. Comm.* XIII, p. 492). Perhaps when the consideration was technological the situation was inevitable; when commercial avoidable. With regard to brands, there are still merchant brands of malleable iron, with over a century's tradition, which have as good a hold on the market as the well-known makers' brands. Some makers only produce merchants' brands—they do not have or do not use brands of their own.

[2] Probably integration and analogous influences could most effectively be countered by similar weapons: and in many districts this may have been impossible in the absence of horizontal fusions.

[3] *Iron Age*, Nov. 10, 1898, p. 15.

[4] *Ibid.* May 30, 1912, p. 1349 (Steel Corporation Dissolution Suit; evidence of J. Stevenson. Stevenson said his first plant, capitalised at \$1 million, was sold for \$3·3 millions).

handicap, and a serious source of weakness in competition with firms like Carnegie's, or Jones and Laughlin's, who could conserve resources and spend freely on new plant or new minerals without reference to the market value of their stocks or the possibility of good immediate dividends.[1] Even the Steel Corporation was disturbed by this sort of thing at the outset.[2]

In Germany and Great Britain, for reasons which will be shown later, the forces which led to the overcapitalisation of amalgamations in the States had other manifestations, proving a barrier in the way of amalgamation or else limiting its effectiveness. It has been seen that in Germany horizontal amalgamations of big firms were less common than in Britain prior to 1905, and that they were of little importance in either; instead, in both countries, family businesses played a big and not rapidly diminishing part in the industry.[3] The inducements to the merging of such concerns, and to the consequent loss for one or more families of absolute control, with its promise of both security and power, were presumably too small or too uncertain. Indeed this was apparently so much so in Britain that when amalgamations were formed they appear often to have been on such terms that as little as possible of the individuality of the participating concerns was lost; a weakness as immediately

[1] Carnegie always emphasised the strength of his "family" business in this respect; when he sold out he saw to it that his holding in the Steel Corporation was wholly in bonds: Hendricks, *op. cit.* p. 498.

[2] Jeans estimated that to cover bond interest and 7 per cent on ordinary shares the Corporation had to make 20*s*. per ton of steel, Jones and Laughlin about 6*s*. Jones and Laughlin's nominal capitalisation dated from 1899. Cp. *Amer. Indust. Compet.* (1902), p. 8. American observers thought that the anxiety of the Corporation to pay early dividends led it to neglect opportunities to buy more ore lands cheaply (*Iron Age*, Jan. 4, 1906, p. 28). There was certainly some initial perturbation within the Corporation, which appears to have ended by Frick displacing Schwab as the controlling force, an earlier change in Carnegie's being thus reversed. G. Harvey, *Life of H. C. Frick*, pp. 257, 273.

[3] This is well known for the British industry, perhaps less familiar with regard to the German. Cp. *Kont. V. u. d. Kartelle*, IV, p. 235. Herr Schaltenbrand, President of the new Stahlwerksverband, in explaining why the Trust form of organisation was ruled out for Germany, started by emphasising that "a great number of our works (may I say God be thanked!) are in family ownership: even when they have assumed the form of a company, still the ownership of the shares is retained closely in a small circle, and the owners are determined never to let their works out of their control".

serious as overcapitalisation and often less easy to eradicate. It is a remarkable fact that elimination and specialisation of plants was not a rapid consequence of the fusions of the late 'nineties and the early years of the next decade, and this was not always, if ever, because such steps offered no economy.[1]

The importance of market conditions as a check to the rapid establishment of high-capacity plants in Great Britain was then clearly considerable. The importance of the disparities in capital market structure, affecting both the raising of capital and the organisation of amalgamation, is more difficult to judge.

The main distinctions are familiar. In Germany and the States, but not in Great Britain, the chief investment banks undertook to handle the share issues of industrial firms—and handled share issues of the steel industry very extensively. In Germany the chief investment banks were also the chief deposit or "credit" banks, and a process of amalgamation and absorption had concentrated the business into relatively few hands.[2] These composite banks were quite ready to hold shares in firms whose accounts and issues they handled, and they were often as a result represented on the board of the firms. Even where there was no formal link of this kind, personal contacts between the

[1] I have been informed in one important instance to this effect by the present directors. The insistence of Lord Wimborne that Dowlais should continue in operation has been referred to above. The union of Stewarts and Lloyds' led to little if any change in the distribution of work among the various plants. The union of Dorman Long's with Bell's was not horizontal, but although Dorman's had for long made steel the fusion actually brought a new steel plant into operation; for Bell's had been unsuccessful hitherto in making steel, though they had been trying with the aid of a French chemist since 1890. Dorman's succeeded in using Clarence pig from Cleveland ore for steel by adopting the advice of the British metallurgist Saniter. That Dorman's allied with Bell's was possibly due to the fact that Bell's had the best ore in Cleveland after Bolckow's. It would not be surprising, however, if the resulting firm should properly have been known not as Dorman Long but as Dorman versus Bell. It is interesting to note in this context that Schwab found difficulty in the early days in introducing more specialisation among the plants of the Steel Corporation: "Each company is so interested in its own business, it is hard to get them to make bargains: each wants to drive so hard a bargain with the other" (*Rep. Indust. Comm.* XIII, p. 453).

[2] Cp. for example P. Barrett Whale, *Joint-Stock Banking in Germany*. "Deposit bank" is a slightly misleading term here, since it suggests too great a similarity to British institutions.

leading investment bankers and the big industrialists were close and frequent. Herr Fürstenberg, for instance, who shaped the fortunes of the Berliner Handelsgesellschaft (one of the chief issuing houses), travelled so often to Westphalia that he felt at home in the sleeping car, and he knew well all the leading personalities: Krupp, Haniel, Stumm, Thyssen and Stinnes ("the real rulers of Rhenish Westphalia"), being on terms of close friendship with some of these and with others less well known, such as the Baare family of the Bochumer Verein. In the States, as in Germany, investment banking and deposit banking were linked, and the willingness of banks to make long-term investments in industry was sometimes important for steel; but the organisation and floating of giant companies was usually the work of promoters other than the banks handling the current accounts of the firms concerned.[1] With the floating of the Steel Corporation by Morgan's the relations of the banks and steel firms possibly became more intimate; such at least is suggested by the facts elicited before the Pujo Commission on the "money trust" in 1912.[2] In Great Britain deposit banking and investment banking were of course strictly separated. Deposit banks (many of them provincial, not London, banks) were frequently represented on the boards of iron and steel firms; often as individuals, and occasionally as institutions, bankers held steel firms' shares,[3] and these connexions were no doubt valuable in obtaining short-term loans, and sometimes perhaps in obtaining

[1] It was not invariably the same bank that handled the current account and issue business of a firm. The Berliner Handelsgesellschaft was not a bank with branches and did not aim at a big deposit business: Carl Fürstenberg explains in his important autobiography that the deposit business had no attractions for him. When an industrial firm wishing to issue shares kept its banking account with a local firm lacking good access to the money market, it would naturally take its issuing business to one of the bigger institutions. The whole German position was admirably surveyed in Otto Jeidel's well-known work which has been cited earlier (above, p. 226, n. 2). For Fürstenberg in particular, Carl Fürstenberg, *Lebensgeschichte eines deutschen Bankiers* (1929), esp. p. 167 and pp. 368 sqq.

[2] The *Pujo Report* shows for example that there were interlocking directorates connecting the Steel Corporation with the Lackawanna and Pennsylvanian Steel Companies, these links arising out of the connexion of all three firms with Morgan's.

[3] At least twenty-six important firms in the industry had bank directors on their boards. Lists of shareholders reveal very frequent investments by bankers. Where banks themselves held investments it may have been as a result of accepting the shares as collateral. But some holdings were retained for long periods.

long-term loans, particularly in the absence of recourse to the organised stock market.[1] But British banking did not give the steel firms the intimate contact with the long-term loan market which German and to a less degree American banking did. Moreover, since British banking was rather less concentrated than German, bankers were probably much less able to have an intimate view of the industry as a whole, such as would be valuable to the firms they served. British firms possibly gained more in this respect by having on their boards men who were also directors in one or more analogous companies.[2]

The influence of these contrasts of financial structure was probably fourfold. First, the British industry was less able to raise capital in the London money market than the German industry in Berlin or the American in New York. Secondly, the supply of new capital in Britain varied more than in Germany with the fluctuating fortunes of the industry. Thirdly, German facilities were better suited to promote amalgamation. Fourthly, the German and to a less extent the American systems aided the emergence of a co-ordinated policy within the steel industries of those countries.

That the British industry borrowed far less in London than the German industry in Berlin was commonly known.[3] In itself

[1] Lord Wimborne noted among the other advantages of the sale of Dowlais to the Patent Nut and Bolt Company that Arthur Keen was director of a large London bank (*I.C.T.R.* July 6, 1900, p. 16). Probably a firm with such a contact would the more easily obtain loans on personal security. Lord Wimborne remarked there was "no fear that the till would ever be at all short".

[2] This was fairly common, e.g. David Dale was on the boards of Barrow and of Consett; Charles Markham on the boards of Park Gate and Palmer's; F. W. Bond on Dorman's, the North-Eastern Steel and Richard Thomas; Arthur Keen on Bolckow Vaughan's board, etc. The Workington and Whitehaven iron and steel companies were very closely linked.

[3] The statistics are difficult. For the Berlin Bourse information published by Jeidels, *op. cit.* pp. 174–5, suggests there were ninety-six issues for iron and steel (not engineering) firms between 1897 and 1902, whose total value was £29 million. In London in these years there were seventy-seven issues (debenture and share issues being separated, though these were commonly made simultaneously and in one prospectus) of a total value below £16·25 millions. Part of six issues valued at £2·7 millions were issued by companies first to their existing shareholders. Of the London issues nine, valued at £4·9 millions, were for the big integrated armament and shipbuilding firms. Many London (but few Berlin) issues were for the purchase of existing businesses, not the provision of new capital, and the lists show that much of the money was subscribed locally.

this need not mean that access was poor. Many members of the industry did not feel that the sources of their capital supply were restricted;[1] and the British industry no doubt had more sources outside London than the German industry outside Berlin.[2] Even in Germany it was noticed that the family businesses of the old Silesian heavy industry had little recourse to the investment bankers.[3] Nevertheless, there are indications that capital could be raised in Germany in circumstances which in Great Britain usually proved unfruitful. Jeans, who was secretary of both the national organisations in the industry, wrote in 1904 that while he had known "many promising schemes for new iron- and steel-works" put forward—he must have meant schemes for high-capacity plants—"they almost always came to nothing". "The general investor does not favour schemes of this kind."[4] Possibly among these schemes was one for a works in the East Midlands, which he mentioned in *American Industrial Competition* in 1902, but of which nothing more is heard.[5] In Germany such plans were from time to time successful in Berlin, and sponsored by the banks, the shares being presumably taken up by the "general" investor. They were not numerous, but the thing could be done.[6] The nearest approach to it in England, the floating of a large issue in 1904 by the Cargo Fleet Iron Company, was only a success because the major part of the ordinary capital was subscribed by a rich parent company (the Weardale Company) and, in a curious way, by the shareholders of an associated company (the South Durham); while the parent

[1] This is the impression given in the *Rep. Tariff Comm.* There were occasional complaints of capital shortage, but the structure of the investment market was rarely complained of till comparatively late. See, however, *Engineering*, Jan. 27, 1893, pp. 96–7. In 1910 *I.C.T.R.*, asserting that "British firms of repute have been unable to raise money", often advocated German banking methods.

[2] E.g. more big fortunes had been made in the British industry. There were some important provincial *banks* which were sources of capital in Germany.

[3] Fürstenberg, *op. cit.* p. 265 (but see pp. 191–2); and Jeidels, *op. cit.* pp. 202–3.

[4] *I.C.T.R.* Jan. 29, 1904 (leader).

[5] *Op. cit.* p. 123.

[6] There were two striking instances at the close of the century. The Darmstadter Bank helped to float the Differdange-Dannenbaum steelworks in 1899, and on its failure advanced more money and floated more issues for its reconstruction in 1901. The Berliner Handelsgesellschaft floated an issue of £500,000 for extending the Rombacher Steelworks in 1901, a works only recently set up with the aid of the Schaaffhausenscher Bank. Cp. Jeidels, *op. cit.* pp. 47–8, 106.

company guaranteed the debenture interest.[1] In Germany the new firms no doubt had, and needed, distinguished support, before the banks sponsored them. The Rombach Works, it has been seen, had Carl Später behind it.[2] But the capital contribution of the Berlin market here and in other instances was substantial, and a risk-bearing one. Whether the British industry was less well placed than the German with regard to capital issues of a smaller class than those for new big plants is not certain, but it is likely. Jeans thought otherwise—"money for improvements was not lacking". At the close of the 'nineties and later debentures certainly appear to have been raised in London at the same rates as in Berlin, though in rather smaller sums. For a decade earlier than this, however, the German rates were probably below the British.[3] And it is a pronounced feature of the London transactions for the industry that very few after the 'seventies were issues of ordinary shares;[4] which is at any rate consistent with the view that it was hard in London to obtain sponsors for share issues of the industry involving much risk, though in good times there was fairly active business on the Stock Exchange in the shares of well-known concerns.[5] There were, as a matter of fact, London

[1] In 1905, 159,861 Cargo Fleet shares had been bought in exchange for South Durham shares, and the Weardale Company held 504,789 shares of the Cargo Fleet Company, out of a total of a million shares. [2] Above, p. 228.

[3] Until 1895 long-term debentures carried 5 per cent. or more in Great Britain, after 1895 from 4 to 4½ per cent, save for issues heavy in relation to the ordinary capital, or issues by firms in difficulties. Dorman Long's, for example, paid 5 per cent in 1889, 4 per cent in 1900. In Germany the Bochumer Verein borrowed over £200,000 at 4 per cent. in 1887, but paid 4½ per cent. in 1906: the Gelsenkirschen amalgamation raised £1 million of debentures at 4 per cent in 1905—its share capital was £6·5 millions—and the Röchling company paid 4½ per cent in 1908 for a loan of £750,000. (Rabius, *op. cit.* p. 124, n. 2; Däbritz, *op. cit.* pp. 238–9, 355; Nutzinger, and others, *op. cit.* p. 23.) The sums borrowed in Britain were smaller than in Germany perhaps partly because the firms were smaller. By 1900 British life-insurance companies were beginning to take up steelworks' debentures.

[4] The volume of ordinary issues in the period 1897–1902 in London was £4·3 millions, of which £1·5 was by the armament firms. Of the rest the chief issues were concerned with the sales of established firms, the largest—Pease's—mainly a coal firm. The lists of shareholders, where analysed, suggest that the shares were not well taken up, vendors and promoters being left with large blocks—in Weardale, for example, and Walter Scott's.

[5] It is not possible to show whether many efforts to float ordinary shares were fruitless. There was one interesting instance in 1889: the three leading high-grade

investors in close touch with the industry who made successive and successful investments in the younger companies. F. W. Bond, for instance, member of a London firm of metal merchants, was an original shareholder, perhaps a promoter, of the North-Eastern Steel Company in 1881; in 1889 he took shares in Dorman Long's when it was turned into a company, and by 1900 he had a considerable holding in Richard Thomas's.[1] But the structure of the London money market was not adapted to "spotting the winners" in this way, and the "general investor" was likely to obtain from it a magnified view of the risks of the industry, undisturbed by informed opinion.

He might well be moved not merely by the average dividend records but by a traditional distrust both of the industry and of promoters in the industry, born of the experience of the 'seventies. The mid-'sixties had witnessed the conversion of many big iron and steel firms into joint-stock companies of an advanced type with long lists of shareholders, among whom there was often no small group exercising a dominant influence because it held a majority of the shares.[2] The organisation of such companies was pioneered in Manchester, but a considerable number of shareholders were Londoners, and the chief Manchester promoters, the accountants Chadwick and Adamson, set up a London branch.[3] In the early 'seventies there was a renewed activity in company promotion, but the companies

sheet makers in the Black Country (Baldwin's, Hatton's, and Thomson's) set out to form a combine and sell out to it; but the vendors found that they were left to take up a large share of the ordinary capital, for which there were few subscribers. The scheme fell through: *I.S.T.J.* July 20 and Aug. 10, 1889.

[1] The first and last of Bond's investments were not in shares publicly marketed when he took them up; the point made is that with adequate knowledge a London investor was willing to take successive risks in the industry. Other instances may be traced in lists of shareholders.

[2] Bolckow Vaughan's, Ebbw Vale, Consett, and Park Gate, of the big concerns, were of this type. They had, respectively, 370, 500, 660 and 76 shareholders. In the first the directors held almost 9500 shares out of 25,000; but 8000 were the vendors' shares. In Ebbw Vale 20 holders had 31,000 out of 80,000 shares, and there was a Manchester group of seven who held 9000 shares. In Consett the twelve biggest holders had 11,000 out of 40,000 shares.

[3] There were Londoners in all these companies. Park Gate, with 27 out of its total of 76, had by far the largest proportion; of the 27 most came from the district of iron merchants, civil engineers, and stockbrokers, etc.—from Old Broad Street, Queen Victoria Street, Lombard Street, etc. Consett shares were mostly subscribed for locally; Bolckow's and Ebbw Vale drew much from Manchester and from

created were for the most part smaller than those of the earlier period, conversions of family malleable-iron businesses; and, as has already been related, the history of these companies was punctuated by reconstructions and liquidations. Not one in four had given a reasonable return to investors by 1879, according to R. L. Nash, who wrote articles on investment problems for the *Economist*. The "old and giant companies" of the earlier decade had not as a group suffered disaster, but their record was not sparkling.[1]

Of the second group of flotations it soon became evident that where businesses had been sold to companies they had been usually overvalued.[2] Chancery proceedings showed that the most reputable of the promoters, whose "businesslike and well considered" manner of working was described by its chief partner to two Select Committees,[3] had issued the prospectus of a concern upon whose past history information was refused, and whose valuation was based on a technician's estimate of potential maximum output, valued at prices ruling in 1873. Ultimately what was no doubt Chadwick's worst practice was held to pass muster, but the lay observer was likely to agree with the judge who during the long passage of the case through the courts stigmatised it as "unscrupulous and improper".[4] Strong pre-

investors all over England. These firms, save Consett, were all organised by Chadwick's. Barrow drew a number of investors from London, e.g. Thomas Brassey the contractor, and several other civil engineers from Westminster, were original subscribers. By the next decade Charles Hoare the banker was in, and the political contacts of the Cavendish family (who were part founders) had made their mark. A. J. Balfour, for example, held shares.

[1] R. L. Nash, *Inquiries into the Profitable Nature of Our Investments* (1880), p. 100. When Nash approaches the discussion of iron shares he does so ominously with the words: "Hitherto useful and profitable securities have claimed our attention"!

[2] Earlier reference to reconstructions are indicative of overvaluations at this time; but there were also instances at the time which were complained of later but not adjusted. Cp. *Econ.* Oct. 1, 1904, p. 1587, for Pearson and Knowles.

[3] The evidence is summarised in Clapham, *op. cit.* II, pp. 360–1.

[4] *Law Reports, Chancery Division*, XX, pp. 30 sqq. Chadwick was sued for misrepresentation with regard to the floating of the Blochairn Iron Company in 1873. The prospectus contained the name of Mr Grieve, M.P., as a Director, but he had not consented to serve, being anxious to know the record of the firm first. "Your movements are too quick for me", he telegraphed to Chadwick. In the Investment Circular which Chadwick's firm sent to its "friends" the valuation of the works (ultimately to be the site of the Steel Company of Scotland) was said to be based on the "actual production capacity and profits...over a series of years". The record gives an illuminating view of what was judged within the law.

judices against "those who promote and finance public companies" which were commonly met with after this period were clearly well grounded, though some of the promoters' errors were doubtless the result not of knavery but of a pardonable failure to forecast the change of price trend in the 'seventies. It is likely that this episode of the 'seventies checked the pace and changed the direction of industrial investment in Great Britain.

The larger companies of the 'sixties did not as a group discredit their promoters. But in their turn they came in for criticisms, obviously valid in some instances, which reflected another weakness in the financing mechanism. The broad comment was that "the higher management of great works... as a rule is not as it should be", because, as Edward Williams put it, "for some unaccountable reason it seems to have become the opinion that gentlemen without special training, often engaged in other business of an entirely different sort, and coming only occasionally to the works as directors, can adequately and efficiently control and manage great manufacturies".[1] This was often a direct outcome of the ornamenting of directorates with names likely to impress or attract investors; and inasmuch as promoters in England had in the early years no traditional standing, and with the passage of time acquired a rather tarnished reputation, since, too, they did not always remain associated with the companies they established, it was perhaps often necessary to spread the net of directors wide. The result was not inevitably disastrous—sometimes the remote director

[1] *J.I.S. Inst.* 1879, p. 24. Williams, who was giving his Presidential Address to the Iron and Steel Institute, had recently ceased to be manager of Bolckow's, and acquired blast furnaces of his own. Precisely the same view was expressed by G. T. Clark, manager of Dowlais, as first President of the British Iron Trade Association: *I.C.T.R.* Feb. 25, 1876. Clark looked back with obvious relish to the days of individual ownership and small partnerships, when owners, mostly self-made men, had their attention "confined pretty closely to the details of their manufacture and to its sale at the nearest port". There were no labour unions then, hence no masters' unions. Masters were "self-reliant...rough but not unpopular with their workpeople...and possessed that rare and great gift, the power of managing men". "A sort of natural selection weeded out the weak." But the joint-stock system (which had brought much capital to the industry, and in "many instances worked to the advantage of us all") had changed all that: "Those who supply the capital are not those who manage the trade—so the old corrective is gone", and so on.

brought business with him, as well as money—but the door was open for loose control of works management, and for a hesitant policy of plant development by financiers anxious for immediate returns and suspicious of the professional technician, though unqualified to meet him on his own ground. Of the flotations of the 'sixties two of the most famous—Ebbw Vale and Bolckow Vaughan's—started with directorates largely absentee and inexpert. In the next decade the Welsh board was wholly absentee and inexpert, and the concern, rightly or wrongly, was obtaining a reputation for bad management which it long retained.[1] The few companies floated in later years seem at any rate partially to have avoided the earlier weakness, their leading figures being resident and expert;[2] but the experiences of the early period made a strong impression, and no doubt discouraged the flow of funds into "public" companies,[3] leaving a distrust of company structure among steelmakers as well as among investors.[4]

The German system tended to eliminate the risks both of irresponsible promotion and of inexpert directors. The large investment banks had obviously most powerful inducements not to sponsor unsound concerns, even where they did not themselves take shares in their progeny; often, moreover, as "credit

[1] For Ebbw Vale, e.g. see *I.C.T.R.* July 1875, p. 820, Nov. 1891, p. 566, and *The Times*, June 10, 1907. Till 1891, as its Chairman said in 1907, the company's history was one of "misfortune and mismanagement". It changed managers in 1875 and directors in 1891. Prior to this change its board was said to be the "laughing-stock of London and the commercial world".

[2] Even in 1902, however, Jeans wrote that "the average English director—the typical member of a board—is mainly a commercial man, and he looks with suspicion upon all proposals founded upon the expenditure of large sums of money", being unaware of the "problems of keeping up-to-date, and distrustful of managers who are 'expensive'": *Amer. Indust. Compet.* p. 81.

[3] It is instructive to note how critical the *Economist* was of most iron and steel prospectuses at the close of the century—cp. notes on new issues, for example, on Oct. 22, 1898, Oct. 7 and June 28, 1899, and March 24, May 26, and Dec. 8, 1900.

[4] O'Hagan, *Leaves from my Life*, pp. 268 sqq. tells how in helping to float Kayser Ellison's as a company he "had to combat his hostility to a company". Horatio Bottomley initiated this project. When Lord Wimborne sold Dowlais he remarked that "he had been against selling to promoters" who would have "taken it to the share market". He would sell only to a strong firm able and willing to carry on his old business. The implication is clear: *I.C.T.R.* July 6, 1900. Lord Wimborne thought control by a board better than control by one man, since the works were so extensive: and as his family was represented on the new board he regarded the transaction "more as a combination than a sale".

bankers" they were admirably placed to value the concerns whose issues they handled. It was noted by the British Iron Trade Association delegates of 1896, and confirmed by later figures, that the capitalisations of German firms tended to be lower (in relation to output) than those of British firms; possibly the banking structure helped to bring this about. Further, the great importance of the banks in the investing mechanism concentrated the representation of financial interest on the boards of companies in their hands; and it had moreover a special "supervisory" character. There are signs that the German bankers, who have on more than one occasion professed a keen appreciation of the danger of becoming "amateur industrialists",[1] did not use their power to initiate industrial policies; though they did help, as will be seen, as co-ordinating agents. The names most famous in the German steel industry for the initiation of projects and policies (which the banks assisted) are never the names of bankers, but all the names of men bred in the industry itself or an affiliated trade.

The American system was not as well equipped as the German to eliminate irresponsible flotations, and promoters' fees were notoriously high and greatly increased the capitalisation of companies. The organisation, as Marshall said, lacked the symmetry of the German. But when steel-company issues were handled by a bank such as Morgan's they gained many of the advantages enjoyed by the German issues. Morgan was anxious for the success of his companies, kept a hand on their subsequent policy, and had enormous resources to back them. And while there was far less in America than in England to discourage investment in the industry,[2] and far more to whet the speculators' appetite, there had been enough distress in the 'nineties to give the services of Morgan an appreciable signifi-

[1] *Rep. Macmillan Comm.* p. 168, and Fürstenberg, *op. cit.* pp. 195–6. Also Spethmann, *op. cit.* p. 171 and *passim*. Sometimes bankers were initiators of reconstructions, but usually because their institutions were much involved, e.g. *ibid.* p. 179.

[2] It may be remarked that in England the railways ceased to take as much capital as hitherto after the 'sixties, and investors were thus driven to experiments in "industrials" on the eve of a falling-price period; in the States the same transition occurred on the eve of a rising-price period.

cance as a token of solidity, apart altogether from the value of his contacts. Morgan's support no doubt also eliminated the need for an ornamental directorate. Jeans, writing for the British Iron Trade Association in 1902, said that, by way of contrast with the English scene, there were "very few cases in the United States of directors who are not full-time workers in a business, merely capitalists";[1] and the fact, in so far as it was observed correctly, is almost certainly to be attributed to the structure of the capital market.

The relatively limited access which the British industry had to the London market was in a sense the most fundamental handicap suffered from the contrasts of financial structure. It was certainly the first to become effective, and of the other three, two—the facilitation of amalgamation and of co-ordinated industrial policies—were essentially derivative, and only beginning to have importance by 1900.

With regard to amalgamation the German system was clearly helpful where two or more clients of a single bank desired to amalgamate, or appeared likely to an informed and interested outsider (as the bank may be conceived) to gain from fusion. The bank could bring together interested parties, who might be rivals, and it would probably have very intimate knowledge of the values of the respective businesses. Since firms wished to amalgamate usually to obtain more capital or to escape from difficulties, a bank could also often bring pressure to bear on firms where there were reluctant shareholders, and where any disposition subsequently developed to evade agreements once entered into. The importance of these functions may be best appreciated by reference to the difficulties encountered by negotiators in England, such as are described by O'Hagan in his account of the fusions in the cement trade.[2] Where amalgamations were desired or desirable between firms not having the same banker, the co-operation in a consortium of the two or more bankers concerned might yield some though not all of the benefits achieved when a single bank held the field. Prior to

[1] *Amer. Indust. Compet.* p. 81.

[2] O'Hagan, *Leaves from my Life*, II, pp. 39 sqq.

1905 the services of the German banking system had contributed very little to the emergence of high-capacity steel plants by horizontal amalgamations, and had done more to advance vertical fusions, though even here they had done ostensibly little.[1] They possibly helped much in the horizontal union of the great Phoenix and Hörde firms in 1906: both firms banked with the Schaaffhausenscher Bank.[2] From a much earlier date they appeared to have been important in the coal industry, where the grounds for amalgamation were simple and impressive.[3] Since horizontal fusions were vital at an earlier date for the British steel industry than for the German, it is open to argument that a German-style banking and investment system would have been earlier effective in Britain than on its native soil.

Just as a bank might wish and might be able to aid and hasten the amalgamation of customers, particularly when it held some of the customers' shares, so too it might choose to influence other parts of its customers' policies. Prior to the amalgamation of Hörde and Phoenix there occurred a well-known incident when the Schaaffhausenscher Bank by reason of its majority holding of shares in the latter concern forced its adherence to the newly-formed Stahlwerksverband in circumstances ostensibly disadvantageous for the individual firm concerned, but advantageous for the other steel firms in which the bank was interested.[4] It possibly occurred seldom that, where there was so sharp an opposition of interest, banks had so strong a hold. But there is no reason to suppose the incident misrepresents the general trend; and it is likely that, in considering whether to undertake the floating of a share issue for a firm, banks would take into account the effect of the issue on other customers. Indeed, it appears from Fürstenberg's autobiography that the leading investment bankers, who were on friendly terms, ultimately came to hold intimate consultations with each other prior to

[1] For details see Jeidels, *Grossbanken*, pp. 123–4.

[2] *Ibid.* pp. 50–1, 261–4.

[3] Fürstenberg, *op. cit.* pp. 267 sqq. This is one of the few industrial topics where the author touches on the technological bases of a policy in which he participated.

[4] Jeidels, *Grossbanken*, pp. 111, 147–8, 255–6.

undertaking business, with a view to eliminating conflict;[1] and this clearly may have given an important degree of security to investments in new equipment, lessening the danger of destructive competition.

The final advantage which the German industry may have had over the British by reason of differences in financial organisation was a greater ability to raise capital for new plant when times were bad. Since banks would readily advance money for the purchase of new equipment it was less necessary than in Britain for joint-stock firms to time their extensions according to the temper of the Stock Exchange; and the banks were moreover willing to undertake very large issues of shares, even of unsuccessful or barely established though perhaps promising firms, in most inauspicious years, holding large blocks of the shares themselves.[2] Clearly to the extent that the command over capital was independent of fluctuations the industry was the better able to equip itself in anticipation of good trade, and not during the period of good trade when costs of construction were high and the advantages of good prices were lost. In the States, Carnegie followed the policy of re-equipping during slumps, but asserted, no doubt with his habitual exaggeration, that his corporate competitors were always unable to secure the funds to do so.

[1] "Für mich sollte dieser Wechsel ein Aktivum bedeuten, denn Klönne und ich haben stets zusammengehalten. Die Industriewelt Deutschlands war gross genug, um zwei Industriebanken reichlich Platz zu gewähren, selbst wenn auch noch dem Unternehmungsdrang der anderen Institute genügend Rechnung getragen war. Da ich hier von Dingen spreche, die nicht nur der Vergangenheit, sondern, infolge der durch den Krieg verursachten Umschichtung, heute schon der Geschichte angehören, so kann ich ruhig erzählen, dass Klönne später die Bearbeitung der Industriegeschäfte bei der Deutschen Bank nur unter der Bedingung übernahm, dass die Bank für Rheinland-Westfalen und für die Saar in intimem Einvernehmen und in voller Gleichberechtigung mit der Berliner Handels-Gesellschaft vorgehe. Viele gemeinschaftliche Geschäfte sind das Ergebnis dieses Übereinkommens gewesen": Fürstenberg, *op. cit.* p. 194.

[2] There were important instances—particularly those of Rombacher and Differdange, hitherto mentioned. But it is to be noted that the total number of issues, both of shares and of debentures, but particularly of shares, fell greatly in 1901–2; and the advances of these years which suggest some independence of fluctuation may merely reflect a wise recognition that further expenditure was needed to make an earlier investment remunerative: Jeidels, *Grossbanken*, p. 172.

There was probably, it should be said, a compensating feature in the British financial structure, a service rendered to the British industry more extensively than to the German or the American, namely the securing of orders by foreign and colonial loans; for the issues with which the chief London houses were preoccupied had, unmistakably, industrial rewards. Loans for development works abroad resulted frequently in the appointment of British consulting engineers and of British directors; and these by reason of their traditions, friendships or investments advocated and secured the use of British products. It is noticeable that British steel firms held their export trade particularly well in the products where consulting engineers played an important part;[1] and many firms had consulting engineers and contractors among their shareholders.[2] Hence the German industry's leaders pointed to British financial power as one of the manifest reasons for the continuance of protection after 1900.[3] Yet the British relative advantage here was by then rapidly diminishing. Foreign public works were becoming more autonomous; there were native contractors, accomplished contractors in rival exporting countries, and there was a decline in the relative importance of the contracting system; while other countries' bankers, above all Germany's, were competing in the foreign loan business with increasing success, taking orders to their own countrymen.[4] Perhaps the expanding German banks

[1] E.g. British makers retained a relatively strong hold on the rail trade. At the present time they usually exceed their quota in the International Railmakers' Association. This is, it is only fair to note, often stated by British makers to be due to quality. In the bar trade, of which only a small part was influenced by consulting engineers, the British position was weak. Tacke, *Kapitalausfuhr und Warenausfuhr*, shows well the connexion of investment in Chinese railways and exports to China.

[2] I have found this very common; to take some early instances, it was important for Ebbw Vale, Barrow and Park Gate.

[3] *Kont. V. u. d. Kartelle*, IV, p. 292.

[4] Contractors, taking foreign work, appear in France and Germany for the first time in the 'seventies in the persons of Bontoux and the better known Strousberg, of whom the latter at least had learned his business in England. At a later date the German firm of Lenz, financed by the Berliner Handelsgesellschaft, had a very important railway-building business. (Cp. e.g. Fürstenberg, *op. cit.* pp. 57–70, 130, 145, 280 and *passim.*) The German and American activities as bridge builders are well known. A very illuminating comparison of British and rival contractors is given by C. du Riche Preller in *Engineering*, Jan. 27, 1893, pp. 96–7 ("Causes of

co-ordinated their foreign loan business more intimately with home industrial development than was done in Great Britain: they were in a position to do so. Nevertheless the British bankers and investors probably still exerted the major influence.

But it is to be remarked that however much this primacy added to the volume of the British steel trade, whether in directly exported goods or in steel used at home for engineering products subsequently exported, it is unlikely that the whole or even a major part of this addition was open to the competition of the whole British industry; for the addition was the result not merely of preferences for British goods in general, but often of specific preferences based on personal contacts, traditions, experience, and interests. Probably the older firms in the industry were most helped; which in Britain often meant firms unfavourably situated for minerals and for expansion. In so far as this happened, the financial influence exerted on behalf of the British industry helped to perpetuate the structural *status quo*, to prevent the quick emergence of new powerful plants, and did not tend to counteract the influence exerted by the relative shyness of London towards the share issues of the industry.

"Imperfections" of competition, which though universal were peculiarly significant for the British industry, and the structure of the British capital market were the chief obstacles to the emergence of new high-capacity plants in Britain, and the most fundamental influences likely to cause a divergence of British and rival growth. There were, however, other contributory influences.

In the first place, the import of foreign steel at low prices, assisted by tariffs, was unfavourable to the undertaking of steel manufacture by re-rollers, and, to a less degree, by other steel

British Decline"): "The old tradition was elastic and lavish estimates....This covered miscalculation (and) there was a stupendous waste of material and money over great works....The old engineers may be excused as pioneers, (but) they were also monopolists. Now there is competition, and we feel the effect of this through the thorough training of the Continental and American engineers....The initiation of works abroad, the negotiations and the superintendence...require at the present day not only professional efficiency but culture, diplomatic skill and linguistic attainments....In that higher intellectual training...the ordinary engineer is deplorably deficient."

users; a step which might have helped the growth of new and big plants, and was perhaps essential for the rapid development of the East Midlands. The import trade increased the movement of re-rolling trades towards the West Coast, towards sites which were well placed both for exporting and for obtaining cheap supplies of semi-products; and this unquestionably increased the handicap of the East Midlands. During the later stages of the westward movement, when Lysaght's went to Newport, and John Summers' to Chester (perhaps not, in this instance, to obtain foreign semis),[1] the potential strength of the East Midlands might have been evident—indeed a Lancashire re-roller emphasised the cheapness of Lincolnshire pig iron when the Iron and Steel Institute discussed foreign competition in 1901.[2] Almost certainly this strength was not generally appreciated, and it is legitimate to hold that there was some lack of foresight here. But the immediate advantages of moving west were far more tangible than those of moving east. Marketing from East Coast ports would need organising; there were transport costs to the coast which Black Country makers had learned to fear; and open-hearth steelmaking advanced slowly in the district, while the adaptability of the ores to the Thomas process was barely recognised and received no publicity.[3] A re-roller who moved east about 1900 would thus undoubtedly have been taking—in the words of a Black Country producer who recalls the earlier period[4]—"a very long shot". And as the Continental semis were often better suited in quality than the British to many re-rollers' requirements, and also cheap, there was a strong inducement to such re-rollers to remain "pure" and unintegrated. For unless there were a reduction in semi-product costs integration offered no certain gains; there were no fuel economies to be had by the adjacence of re-rolling and

[1] Both firms moved in 1899. The advantage of Chester was its proximity to Liverpool, with its admirably frequent sailings to all ports, vital in a trade where the time for delivery was often short, and business was almost wholly for export.

[2] W. H. Bleckley (of Pearson and Knowles), in *J.I.S. Inst.* 1901, I, p. 120.

[3] I know of no reference to it at all.

[4] His father had himself contemplated moving to the West Coast, but not East; and finally did not move at all because of his local political interests.

earlier processes save where re-heating could be avoided—but this was rare—and the elimination of the transport of "semis" was not always a gain unless the consuming market was local. It might be a loss.[1] Moreover, a firm with a big varied re-rolling programme might benefit by having access to different sources for billets, since it might require several qualities which could not be made equally well if at all in a single melting-shop.[2] It is significant that where commercial integration of steelmakers and re-rollers occurred in Germany and the States they were not invariably quickly followed by technological integration, and it was recognised in the States by so expert a consultant as Julian Kennedy in 1912 that unintegrated sheet, tinplate and merchant-bar mills (of which there were many in the States) might be quite profitable.[3]

The same factors which made it uncertain whether integration of steelmelters and re-rollers would be on balance advantageous made it unlikely that this kind of integration on the part of engineers (in all branches) would be so; though the opportunity of using foreign steel ranked far less high among these factors with regard to engineering than to re-rolling.[4]

In the second place, the British industry was probably less well placed than the German for the establishment of new high-capacity plants through the initiation of merchants.

[1] The transport of semi-products would usually be at a cheaper rate than that of re-rolled products, if only because the individual shipments would be larger. Hence it might be cheaper to dispatch semis to a works near the final consumer and re-roll at the market, than to re-roll where the semi-product was made and carry the finished product to the market. The finished product would always be of less weight than the semi from which it was made, but the difference (often not much above 5 per cent) would not compensate for any appreciable rise in railway rate. It might even be offset by the weight of packing material in a few instances.

[2] It has been seen earlier that in Britain great elasticity in the rolling capacity of strip and bar mills was essential for high-capacity working.

[3] *Iron Age* (*Rep. Stanley Comm.*), Feb. 1912, p. 892.

[4] In the tinplate industry it should be noted the import of semis was not very important at the time; partly because Thomas steel was usually not suitable, partly because orders were small and for very varied sizes, and could not be supplied adequately by a trade in stock sizes. But dumping is most effective in stock sizes. It is also stated that the time allowed for delivery of tinplates often did not allow quotations for special orders to be obtained from Continental makers. These were no doubt contributory factors in the spread of integration in the tinplate trade.

Largely as a result of the dispersion of production and the competition between producing districts, and of the great importance of London as a centre of sales, the merchant trade both for the home and export markets was very greatly subdivided.[1] It is quite likely that no single merchant firm had sufficient assured business contacts for the sale of a narrow range of goods such as could be made by one mass-production works to encourage it to take the main risk in setting up a powerful new plant; particularly, again, in the East Midlands, whose products had no reputation and were handicapped by the "basic" prejudice.

In the third place, there was a group of influences active in the States but not in Great Britain, which promoted monopolistic amalgamations, and hence indirectly helped the concentration of production in large plants. It was, it is true, partly with a view to obtaining advantages from such concentration that the amalgamations were formed; all the monopolies in re-rolling and analogous trades—in wire, hoops, sheets, tubes, tinplates, etc.—eliminated the less efficient and less well-placed plants, transferring equipment sometimes from one site to another. But the origin of these unions is probably to be found less in the economies of large-scale working than in the very acute character of the competition in the trades, and the advantages of monopoly in making use of the tariff. The bulk of the trade in these products was in common-grade qualities, and was conducted by firms which started with little capital

[1] This much is evident from the fact that the majority of makers had several special agents, one in London and one or more in other markets—Birmingham, Liverpool, Newcastle, Glasgow, Hull, etc. Merchants rarely had branches: they normally worked in one home market only. Perhaps because of the agency system and the multiplicity of plants, it seems that the successful merchant firms grew more by taking up new lines than by extending existing lines. They became agents for makers of different grades and forms of steel products, sold machinery, went in for contracting and constructional work, and dealt in imported ores and in non-ferrous metals. Possibly most of the exporting merchants, while they increased the variety of the products they handled, specialised on a few markets geographically. *Ryland's Directory* includes some relevant information; some of the steelmakers included agents' names in their entries; and some agents whose names were not so advertised remedied the omission in their own entries. The geography of the exporters' businesses is mapped out to some extent in *Ryland's Directory of Merchant Exporters*. But statistics of the structure, save the most elementary, are lacking.

and were engaged in making one product only. The protective influence of integration, diversification and the manufacture of specialities was therefore negligible. For all these products there were spectacular increases in demand in the 'eighties and later, associated with ranching, meat packing, and the oil and natural gas industries, and as a result very high prices ruled for a short spell, all the higher because of the "Chinese wall" of tariffs. A great number of newcomers entered the trades, which indeed were largely in the hands of young, unsubstantial firms. By the late 'nineties productive capacity had been unduly extended, and makers were being "chiselled by the purchasing agents".[1] And since home makers now had most of the trade in all products, it was no longer possible, as in the rail trade of the 'seventies, for the home producers to suffer a fall in price without a fall in the volume of their trade, since the foreign suppliers could no longer bear the brunt of shrinking demands. Since, however, ultimate prospects were good, capital was forthcoming for a reorganisation of these industries such as would eliminate or minimise price cutting and would offer also some gains through concentration, through the avoidance of cross freights, better bargaining power in buying semis, and in some instances through an extensive export trade: for it was known that once a higher home price was obtained it might be advantageous to keep surplus plant active on export orders. These conditions were lacking in Britain; there were no spectacular new demands, no tariff to accentuate their influence on price or to hold out a prospect of dumping.

The monopolistic amalgamations of re-rollers and the like

[1] The phrase is Julian Kennedy's, referring to tubes. *Rep. Stanley Comm.*, *Iron Age*, April 4, 1912, p. 487. The situation in the tinplate industry is described in *Rep. Indust. Comm.* IX, p. 395. For the wire trade see Tarbell, *Life of E. Gary* (1925), pp. 75 sqq., where the early history of J. W. Gates is portrayed. Gates, a salesman of New England barbed wire in Texas, succumbed to the temptation to use his order book as the foundation of a new works of his own at St Louis; whereby, becoming a thorn in his former employer's side, he was enabled to join him in partnership. From the merchants' standpoint the position was expounded to a jobbers' congress by J. O. Foot, who traced Trust formations to the continuous beating down of prices by merchants till "the manufacturer must either make rubbish, sell out, or protect himself by combination": *Iron Age*, June 21, 1900, p. 57.

in the States were naturally in a position to disturb seriously the chief makers of semi-products for sale, either by transferring orders or by manufacturing for themselves. The beginning of this disturbance was largely instrumental in bringing into being the United States Steel Corporation, whose central feature was a semi-monopolistic union in heavy steelmaking. The Federal Steel Company (a Morgan concern) was about to lose the custom of the wire trade in 1900, and Carnegie's, threatened with the loss of its business in tube-strip to another Morgan company, planned an integrated tube-making plant on the Lake Erie coast at Conneaut. These giant interests preferred to avoid mutual conflict: and they effected a combine which gave scope for a higher degree of specialisation of plant than had ever been achieved, and gave great strength for exporting both by its influence on price and by the size of its resources and business. But it seems right to regard the decision to amalgamate, and the scale of the union, as dictated not by the requirements of technology or management (indeed the gains of specialisation were possibly offset from the start by failures of co-ordination, and later perhaps by costs of distribution) but by a set of fortuitous circumstances, and in particular by those unions in the finishing branches of the trade which were themselves a token of peculiar local conditions.

Finally, the nature of the American ore supply was likely to encourage large-scale operations in heavy steelmaking. The long transport, longest for the best ores, could be cheapened only by the use of high-capacity mechanical equipment, used intensively; hence it tended to fall into the hands of a small number of very large firms. This was notably illustrated by the rail carriage from Mesabi to the Lake Coast, which was in the hands of two companies, one tapping the east of the range, the other the west;[1] these companies were also the largest mining concerns, though they were not in this respect monopolists. There was manifestly

[1] The rail journey from the mines to the coast was over 100 miles, hence it was not possible to have the sort of organisation there was in Spain, with a railway almost for every mine. Control of the railway naturally gave also control of port facilities. The lake transport was never so completely monopolised as the railway

a risk that mining companies with railways would make monopoly profits on the transit of the ores of other mines; a risk whose reality is exemplified in the early history of the Steel Corporation, which according to the accountant of the Stanley Committee of Congress made a higher rate of profit on its ore transport trade (where it had a monopoly) than in later stages of its business.[1] The eastern of the two Mesabi mining and railroad concerns, the Minnesota Iron Company, was from the start linked by personal contacts with the Illinois Steel Company. The other came early into the ownership of Rockefeller, arch monopolist of Standard Oil. Carnegie at once recognised the threat. "That's like owning the pipe line", he wrote; and in 1894 he entered the field himself, first buying mines, next making an agreement to work all Rockefeller's mines on a royalty basis; the possibility of a dangerous rivalry in the steel business being thereby eliminated.[2] Such an arrangement was only possible because of the scale of Carnegie's operations: otherwise Rockefeller would almost certainly have set up a vast steelworks. As things were, though Carnegie had no freight advantage over rivals, he had control over the larger part of such of the Mesabi ores as had been opened up, and no doubt had a cost advantage thereby over other makers (save perhaps Federal Steel) which increased the pace of his firm's growth. When the Steel Corporation was founded it united the two chief ore and ore-transport companies, and other steelmakers were forced to pay tribute to it in the railway rates on their ores, and to give it therefore a differential advantage. This they could not avoid, but they set out to avoid paying further tribute by buying mines, owning their own ore ships, employing independent ships, and sometimes having their own railway from the ore-receiving port to

transport. After 1900 a new railway began tapping Mesabi, but the chief owner, Hill, also acquired great mining interests, and he maintained the same rates as the older lines. (*Iron Age*, Jan. 4, 1906, p. 27, traces the rise of the Hill holdings.)

[1] *Iron Age*, March 1912, p. 590.

[2] Mussey, *op. cit.* pp. 110 sqq. and Hendrick, *op. cit.* pp. 389 sqq. Rockefeller and Carnegie were both able to buy ore properties cheaply because of the depression, though Carnegie, coming later, did the less well, and less well than the Michigan Iron Company.

their works (as Carnegie had had in the late 'nineties).[1] These steps were open only to big firms; hence from all aspects the ore situation tended to favour high-capacity working.

In Great Britain there was nothing parallel to this in scale, although in some districts the condition of ore supplies exercised an influence on structure, particularly in Cleveland, where the fact that the best ores were in the hands of two firms, and that all the deposits had been opened up by 1900, helped to shape development; it probably explains, as seen earlier, Dorman's union with Bell's. But the influence exerted here was not favourable to large- rather than small-scale working; it merely restricted the number of persons who might, if they chose, work on a large scale. In Germany, too, the competition between the Rhine, the Dortmund-Ems Canal, and the railway from Lorraine, as carriers of ore, the national ownership of the railway and the competitive nature of the Swedish ore trade, meant that monopoly in the ore trade was not a potent factor favouring large-scale working.[2]

To sum up the position (as so far analysed) with regard to the lateral expansion of plants and the establishing of new ones of high capacity, it may be said that for the successful undertaking of large-scale operations in Great Britain it was necessary for the promoters of an enterprise, save with very rare exceptions, to be assured in advance of a greater part of their market than was necessary in Germany or the States, and to be able personally or through their personal contacts to supply a greater proportion (indeed the major part) of the capital required. Hence a relatively much smaller number of people held the key to this kind of development in Britain than in rival centres.

[1] The purchase of mines was also partly a result of an ore pool organised in 1895. Jones and Laughlin, the Republic Iron and Steel Company and, among smaller firms, the Central Iron and Steel Company (of Harrisburg) were among those with Mesabi mines: *Iron Age*, Jan. 4, 1906, pp. 26, 44. Details of the extension of ore-carrying fleets other than that of the Steel Corporation are given in the same journal a fortnight later (Jan. 18, p. 25). Jones and Laughlin built their own railway from Lake Erie to Pittsburg (Popplewell, *op. cit.* p. 70).

[2] It is of course unquestionable that the savings due to mass handling of ore at the works were an inducement to large-scale working; but this has been considered earlier, and is not relevant here, since it was not an international differential.

And of those who held the key several were distracted by competing enticements—as the re-rollers by cheap foreign billets; while in Germany the scale of the merchant firms, and in America the state of the re-rolling trades and of the ore trade, were influences positively favourable to change which had no counterpart in Britain.

This did not mean either that change was beset with insuperable obstacles in Britain, or that it would have been unremunerative. It may certainly have offered a slightly lower rate of remuneration than in Germany or the States, since the displacement of old by new productive capacity would have been proportionately greater in Britain. But there is little doubt that the promotion of new works or expensive reconstructions might in a number of districts have been financially justified.

In the East Midlands, in South Wales, and in South Staffordshire promotion could have been undertaken largely by consumers who had no investments in steelmaking to write off, though they might have malleable iron plant whose devaluation would be a little hastened. In the East Midlands prime costs could have been probably as low as the lowest German or Belgian figures, and transport costs would have provided an effective barrier to dumping; le Neve Foster, manager of the Round Oak Works, thought the same would be true even for South Staffordshire.[1] In South Wales a plant catering primarily for local demands not supplied by the import trade—the biggest was of course for tinplate bars—could have been well placed also for exporting.[2]

On the North-East Coast consumers were more handicapped in taking the initiative alone than in the districts so far surveyed. For the most promising advance was to exploit the basic process with more modern equipment, and more command of scientific

[1] *Proc. S. Staffs. Inst.* XVIII, 54. Mr Le Neve Foster, advocating "a large central works owned by the various iron masters of the district to supply themselves with blooms and billets", said it was "possible to make steel billets in South Staffordshire cheaper than they were being imported from Germany".

[2] When it is suggested that consumers might have encouraged the development of East Midland ores it is not implied that this would necessarily have involved formal integration commercially, still less technologically. Re-rolling might well have been moved to Goole or Immingham or even Hull, to be near Lincolnshire semis.

skill; but the best sites were taken and the ores were all held by smelters, who were usually also steelmakers or held large investments in steel plants. Nevertheless, even here the most adventurous enterprise was undertaken by Sir Christopher Furness, who was first a shipbuilder and engineer, i.e. a consumer, though he had become a small iron and steelmaker by buying the control of the Weardale Company (whose more important work now was coalmining) and by acquiring for that company the old Cargo Fleet blast-furnace works, which had a good site and some ore mines; and the great new combined works which he started at Cargo Fleet thus involved writing off a little capital, but capital which had little earning power.[1] For the firms who owned the biggest reserves and best qualities of ore the policy followed by Furness would have involved writing off substantial capital sums; and there is no means of telling conclusively whether this would have been justified. Since the new Cargo Fleet was only completed in 1913 its full earning power and competitive strength were not thoroughly demonstrated before the war,[2] although it was just proving remunerative. Its career, however, has obvious significance, for the firm had been able to grow and establish itself in face both of local and of foreign ("dumping") competition. Bolckow Vaughan's certainly, and Dorman Long's very probably, could have worked with lower costs than Cargo Fleet if they had had similarly modern equipment and layout: presumably they could have extended their trade more rapidly, and raised their profit. The course they actually followed, which involved for Dorman's

[1] The Weardale plant was old, and much of it was antiquated. Cf. *J.I.S. Inst.* 1893, II, pp. 143 sqq. Production was given up in 1900 and the best equipment taken to Cargo Fleet. The old Cargo Fleet furnaces were small and were discarded.

[2] The plant was unbalanced until 1913—too much rolling power in relation to steel-furnace capacity, too little blast-furnace capacity. It had for years to buy molten pig from neighbours. An assessment appeal (*I.C.T.R.* Oct. 21, 1921) showed that after £2 million had been spent, mistakes of layout were discovered, "and a further £1 million was required to make the works effective". The firm made extensive forward ore contracts in 1907, misjudging the future market. In 1909 it began to earn a fair margin of working profit, used largely as "depreciation". In the final pre-war year, a year of declining prices, it made its highest profit and paid a dividend.

between 1899 and 1904 the almost complete replacement of equipment at one steel plant (Britannia) and the building of another (Clarence), with constant subsequent modifications, and for Bolckow's large outlays on important replacements, yielded to neither firm impressive dividends, and left both without any appreciable invested reserves. Their form of depreciation, very common throughout the industry, was a continuous stream of minor expenditures which provided no security against ultimate obsolescence of site or layout. A new small steel plant set up at Skinningrove in 1912[1] is a token at once of the continued promise of steelmaking in Cleveland and the handicap under which other giant but patchwork firms were operating. Competition from Cargo Fleet, if its ores were good enough, or from abroad would probably have forced the older firms to rectify their deficiencies when their resources were ill adapted to cope with them. If this were so, radical change (involving perhaps different amalgamations) could profitably have come earlier, when substantial reductions of prime costs were admittedly within reach, and both firms had good credit.[2]

[1] Financed by A. Hutchinson (whose ironworks were the nucleus of the concern), Pease and Partners, and Guest, Keen and Nettlefold's. Redpath Brown's came in later.

[2] It has been suggested above (p. 249) that Dorman Long's action was largely dictated by their own lack of ores. Their reconstruction at Britannia was in many respects impressive, but the original plans had to be greatly enlarged to make the changes effective, and costs much exceeded estimates. By 1904, as far as one can judge from balance sheets and prospectuses, £300,000 had been spent (output was 150,000 tons/year), and this was not the end. A new mill engine, e.g., was installed in 1905. The site was perfectly placed for supplying "semis" to two firms—a sheet mill and a wire mill—bought in 1899, but Britannia never made many "semis", and the site had the drawback of being too square, the ideal shape being long, to allow the flow of material. Clarence, as an alternative site for all Dorman Long's steelmaking, had some disadvantages; it was by no means an ideal site for ironmaking from local ores, its material assembly costs being some shillings above Bolckow's. Possibly it seemed reasonable to build two plants, since they were not to make wholly the same range of products. It is important to note, in judging the financial possibility of a more thorough change and even a move to a new site, that Dorman's had to suspend operations for two long periods when reconstructing Britannia. The Clarence plant, though virtually new, was subjected to extensive changes in 1903–4: the subsidiary plant had to be changed to get the full output of the mills. This involved intermittent working, and finally closing, in 1904. (Based on reports of Annual Meetings, and the prospectuses issued by the Company.) Bolckow's problem was in some respects far simpler than Dorman's: their site was admirable. Perhaps their major weakness around 1900 was in-

In Scotland the form which radical change might take was clear—the establishment of a combined iron and steel plant close to the shipyards and situated on the Clyde at a point where ore could be unloaded direct from ocean-going ore ships.[1] Such a plan has been often discussed, and could have greatly reduced costs.[2] But since it must have been undertaken by existing steel firms (not because of ore monopoly as on the North-East Coast, but because the consumers on the Clyde were individually smaller than on the North-East Coast and less interrelated: there was no such group of concerns as Furness had developed) the plan would have involved a considerable immediate sacrifice of capital. Makers preferred to adopt the policy of piecemeal improvements and additions to existing plant. This was a policy for which the age and ill-balanced equipment of many of the works gave great scope, but which, being financially in reach of most firms, was likely to intensify competition. On paper most modifications were no doubt rapidly remunerative, inasmuch as they reduced costs, but this advantage may have been almost wholly offset by consequent movements of price. At the close of the pre-war period the Scots makers, as will be seen later, were less able to maintain

decision; they could not get satisfactory results from their converters, but their open-hearth costs were possibly too high for the class of trade they obtained. They tried a duplex process with little success, and ultimately, after an unfortunate incident, decided to give up the converters in 1910. Till they made up their mind on this they could not plan comprehensively. It appears to have been a further weakness that at a time when competing firms (South Durham, Cargo Fleet, Consett possibly, and Dorman's) were becoming in some way or another integrated forwards Bolckow's did not to all appearances partake in this trend.

[1] The weakness of the Scottish organisation was very clearly exposed by E. de Billy and J. Milius, *op. cit.* pp. 251 sqq.: steelworks remote from blast furnaces, production dispersed, ore carried inland, rudimentary plant for finishing and dispatching goods, mills "with all the characteristics of much modified plants" etc.

[2] Bigger blast furnaces would have saved labour cost markedly; John Strain, of the Lanarkshire Steelworks, remarked to the Tariff Commission (*Rep.* § 625) how "the great-capacity furnaces of the States, as compared with the toys here, must necessarily produce very much cheaper; there is one thing as to which we are very considerably behind in this country, that is the pig-iron production and pig-iron appliances". If the furnaces were well placed they would have permitted far more expeditious handling of imported ore, and saved the transport of pig iron to steel-works (the most commonly appreciated weakness); it may have been possible also to reduce costs of delivering ship plates. Large-scale operations would have allowed more uniform rolling programmes and more mechanical handling.

local price associations than other British districts, and prices were lower than elsewhere;[1] yet it is unlikely that the number of firms would have been quickly much reduced, since differences of costs were probably too small. As in Cleveland, the Scots heavy steel firms, where the information is traceable, did not accumulate big reserves or pay high dividends, and the course of events suggests that a more venturesome policy at the close of the Victorian age would have been justified. It is possible that the absence of local ore in conjunction with the advent of foreign competition was a source of indecision. Certainly one of the largest firms[2] was (very commendably) planning to undertake platemaking at Scunthorpe in 1913, a testimony to the opinion that "dumping" competition could be met. But it is hard to believe that there were no Scots shrewd enough to appreciate the impressive advantages of the local market and local scrap (though scrap was less important then than now), or that the high ore costs of Westphalia were overlooked; and the burden of Scottish steelmakers' comments on German competition usually was that but for dumping, which allowed continuous working, the German should have no cost advantage.[3]

3. ASSOCIATION

The contrast between the progress of association in Germany and Britain was determined primarily by the German tariff, and by the binding legal force which restrictive agreements had in Germany alone of the chief steelmaking centres. This does not mean that these were the fundamental bases of association, but that they affected materially the pace and form of its advance.

[1] *I.C.T.R.* Nov. 28, 1913 (leader). [2] The Steel Company of Scotland.

[3] The position on the North-West Coast was perhaps more complex than those examined. Consolidation of production was essential in Cumberland—it came in 1912. But the bad repute of the Bessemer process, unduly exaggerated but influential in selling, made decisions concerning plant replacement hazardous. The situation of the great North Lancashire plant at Barrow was difficult for a different reason—the absence of coal (Workington, of course, had coal). Looking at another district—Rotherham—it is tempting to suppose the proper step, when steelmaking was undertaken by iron firms there, was to move into Lincolnshire; though it is to be remembered that Park Gate, the pioneer of basic steel in the district, was satisfactorily profitable in pre-war years.

As a recent German writer has remarked, the years from 1890 to 1910 (and it is even more true of the 'eighties) were unfavourable to Kartell-building in the iron and steel industry in Germany as elsewhere. "For the establishing of a durable syndicate a certain measure of stability in the conditions of production is unquestionably essential."[1] But in these years important changes of technique, of the scale, nature and location of markets, of raw-material values, and of vertical structure within the industry came so fast that no approach to a competitive equilibrium was possible, the strength and number of rival concerns being subject to frequent and radical modifications. The ensuing conflicts between new, untried, but improving products on the one hand, and established products on the other, between firms with reputations and firms with new plants, firms specialised on the mass production of the commoner-grade products and firms combining the common-grade and speciality trades, "pure" firms and firms integrated backwards or forwards, were not to be satisfactorily resolved by negotiation, since many of the advantages of the combatants were too intangible to measure, and conditions were too fluid. Hence although almost all firms in certain circumstances welcomed a truce, the more vigorous and assertive firms, which were often the younger ones, preferred at most times to "allow Darwin's law of the survival of the fittest to operate";[2] and since they were usually able to improve their position (albeit often slowly) at the expense of rivals who were older and more established, they were quite possibly justified. In Britain, new firms even forced their way into the heavy-rail trade in the 'nineties and early nineteen-hundreds, though the market was shrinking.[3]

[1] Klotzbach, *op. cit.* p. 158.

[2] The law was often appealed to in the 'eighties, e.g. *I.C.T.R.* April 9, 1886, p. 352.

[3] Bell Brothers at Clarence, the Shelton Iron and Steel Company, the Glengarnock Iron and Steel Company (all making basic open-hearth rails) and the Cargo Fleet works (making basic rails by the Talbot process) all entered in these years. They entered the trade despite the existence of the Railmakers' Association, which has lasted since 1896. Cargo Fleet, for example, was allowed a quota in 1906: *I.C.T.R.* Dec. 21, 1906, p. 2176. Spanish firms had also forced the Syndicate (which was international) to give them a quota in 1906, and Russian and Austrian firms were "disturbing" the trade: *ibid.* March 30, 1906, p. 1051.

For the most of time, then, it was scarcely possible to form a durable association, save where association among the makers in one market allowed some of their number at least to compete more effectively in another market. A firm was often, in fact, in a position to choose which of two groups of rivals should bear the brunt of its attack, and it sometimes happened that the richest and quickest reward seemed to be offered by a policy based upon a compromise agreement with one of the groups; an agreement which might be lasting although the mutual competition of the assenting parties had not worked itself out. Such offensive alliances might rest on one or both of two bases; they might make use of either a monopoly in the manufacture of a particular product, or a monopoly of manufacture in a particular locality. Firms making several products (as most did) might enter into agreement with regard to one or two of these products in order to sharpen the edge of their competition in the remainder; or the makers in a single district might associate to fix "remunerative" prices for sales in the local market, prices for sales elsewhere being left uncontrolled (in which case the associates could still in some measure compete among themselves) or specifically fixed at a lower level. The first of these two policies was effective where there were firms making competitive products who did not engage in the monopolised sections; it was most durable when monopoly occurred in the early stages of production, concerned in the manufacture of semi-products for the later, competitive stages. The second policy could be effective only where the local market was large and where production costs were relatively low (this being essential if local monopoly was to be an effective basis for big distant sales); and its effectiveness was all the greater where there was a premium on local products through the greater ease of inspecting their manufacture, and where there was a tariff protection.

Instances of offensive alliance of both main types occurred in Britain and the States. In Scotland, for instance, the boiler-plate makers combined in 1902 to hold up the price of this product, while in the ship-plate trade—a commoner grade and

more thickly populated trade—they sold at exceptionally low figures; hoping no doubt to embarrass the "pure" firms. They were quickly outwitted by a ship-plate maker, who invaded their more specialised territory.[1] Almost all early British associations confined their price policy to local sales, and there is ample evidence that other regions were used as dumping grounds. As an outcome of this, North-East Coast and Scots makers agreed in 1904–6 not to sell, first, plates, and later, angles, in their respective local markets. Later some other areas came into the agreement on the same terms, though it was never national; the interests of some Scots and Welsh firms were irreconcilable, and Scots merchants were uncontrollable.[2]

But several branches of the German industry were far more strongly placed than any part of the British to make this kind of offensive alliance, primarily because the tariff increased the potential value of the local monopoly, allowing prices to be kept above the British and the international trade level, but also because the tariff made it profitable for some groups of makers to exploit their "product" monopoly locally—to compete more vigorously, that is, against some home rivals, as well as against foreign rivals in export markets. Hence alliances here were more lasting than elsewhere.

The distinguishing feature of the situation in Germany was not, it has been seen, the strength of Kartells *throughout* the industry, but their strength in certain branches; particularly in the making of heavy steel products where organisation culminated in the formation of the Stahlwerksverband in 1904. In the bar, sheet and wire-rod trades, and among other re-rollers, effective

[1] *I.C.T.R.* Jan. 1, 1904, p. 28. There had been efforts to form a ship-plate ring earlier; presumably they failed because agreement would have favoured old firms, and given boiler-plate makers scope to use the "coupled bargain", giving concessions on boiler-plate prices to secure joint orders for ship and boiler plates. Boiler plates continued to give trouble. In 1905 it was said that concessions were made on boiler-plate "extras" as a means of securing joint orders. The control of "extras" was strengthened. In 1910 all boiler-plate orders were said to go, with uniform prices, to two famous firms. Other makers were allowed to give a special rebate of 5*s*. a ton till their "allotment" was "booked": *Econ.* April 25, 1903, p. 736, and July 15, 1905, p. 1155: *I.C.T.R.* Aug. 26, 1910, p. 330.

[2] *I.C.T.R.* Jan. 6, 1905, p. 31, and July 15, 1910, p. 88, which gives a map. *Econ.*, Oct. 6, 1906, June 20, 1908. And below, p. 343.

organisation was impossible after 1900. Even among the smelters, agreement was less perfect than among the makers of heavy steel;[1] there were strong outsiders, and despite the elaborate organisation of the syndicate, prices were not by any means continuously maintained over the whole market for long save for a few grades of iron: the syndicate collapsed in 1908. Now quite clearly the makers who were strongly combined were those who held a key position in the industry. The heavy-steel makers were all of them integrated, making pig iron and some re-rolled products as well as heavy steel, and usually owning ore and coal mines; immune from attack by firms less fully integrated, yet able by combining to injure the "pure" re-rollers, and almost of necessity, though not because of the tariff, a thorn in the flesh of the "pure" smelters.[2] By combining they could fix a high semi-product price such as the tariff allowed which handicapped the "pure" re-roller in selling his finished products against their competition, and therefore helped them to get a stronger position in the finishing trades.

Hence the most virile and assertive German makers of heavy steel were likely to be earlier persuaded than the British to give up the policy of dumping heavy products at home, and to sacrifice whatever relative advantage might be obtained therefrom at the expense of other local firms; for the compensations offered to the Germans were much greater.

In addition to this important differentiating condition there was another perhaps not less important. For a number of reasons, among them the influence of the tariff and of the law,

[1] The heavy steelmakers of course had their difficulties. But usually the desire to secure agreement was so strong that compromises were quickly found. Four new firms making semi-products in 1900, for example, were very quickly made members of the Kartell, though their incursion into the trade was greatly resented. Cp. Schaltenbrand, *Kont. V. u. d. Kartelle*, IV, p. 343.

[2] The combined firms regarded pig iron as a subsidiary commercial product only; they liked to sell it in order to keep their blast-furnace plants fully employed, and this was most necessary when the demand for steel fell off. Some would only enter the pig-iron Kartells if their quota was so high that they could not supply it in times of booming trade: hence the output of the pure works had to fluctuate more than the output of the industry as a whole. Cp. Klotzbach, *op. cit.* pp. 86 sqq. 92–3, 99–100, 106, 110, 136, etc. The same problem occurred in England. Cp. *I.C.T.R.* April 23, 1886, p. 598 (Letter from "Redcar").

the growth of Kartells without any accompanying process of consolidation was consistent with a far more rapid rate of cost reduction in Germany than in Britain, and was likely to be itself more rapidly a source of cost reduction.

Kartells brought cost reductions when central selling was instituted, which allowed a distribution of orders among firms so that delivery freights were minimised and melting and rolling programmes were improved; for example, firms were provided with good "runs" in the mills. Now it was important for the advance of organisation of this kind that it was *legal* in Germany; so that if the associates wished, agreements to submit all control sales to a central body could be made legally enforceable. In Britain this was not so. The impossibility of devising a form of agreement which was legally binding is known to have delayed the advance of association in some industries,[1] and though there is no evidence on this specifically relating to the steel industry, makers would clearly be chary of entering into an agreement involving the surrender of direct contacts with customers, without a legally secured advantage in return.

That Kartells were consistent with rapid cost reduction in the German industry—apart altogether from the specific reductions which they made possible—was due largely to the expansiveness of the industry's markets. Both the scale and the importance of this have been traced earlier. The home market grew more in the 'nineties than either the British home market or the world export markets, and the tariff gave the full advantage of this home growth to the native industry. Moreover, of world export markets those which German makers were best situated to supply grew most, and most uniformly, in the same period. These market circumstances favoured more rapid extension of plants without elimination in Germany than in Britain; and the occurrence of this growth of plants (which was also furthered of course by other factors) meant that German prime costs fell more than British, and that as a consequence German exporting power grew more than British. The German industry was thus enabled to increase its share of international trade, to penetrate

[1] O'Hagan, *op. cit.* II, pp. 73–4, 314–15.

British markets and depress prices there. Success in this, bringing an increase in the proportion of low-price export to high-price home sales, involved a sacrifice—the dissipation of the high profits to be derived from Kartell prices behind the tariff. But so long as the combination of home and export trade yielded what was deemed a reasonable profit, and there was competition in plant-building though not in price, such dissipation was inevitable. And the process of dissipation allowed a greater rate of technological advance than would otherwise have been possible without a radical change of firm-structure—far greater than was possible in Britain, where the safety-valves which the German industry possessed were lacking. Successful Kartells anywhere were bound to strengthen existing firms, to refill depleted reserves, and allow the ill-equipped to repair some of their deficiencies. This happened in Germany, and led to much recrimination there. But in British conditions the effect was inevitably more serious; and, failing some other compensating structural change, monopolistic association was bound to restrict appreciably in Britain the advance of the basic process, of large units, of units in the newer producing areas. In the circumstances energetic makers or would-be makers might well prefer other methods than rigid association for avoiding destructive competition—the cultivation of specialities, for example, or the formation either of horizontal mergers, or of extensive vertical combination with consumers, as means to increased sales and thus to lower costs by mass production.

The differentiation of British and German development is thus readily explicable. There was also, however, a broader aspect of the history of association which is in a sense more fundamentally important; namely, the gradual emergence everywhere in the industry of conditions propitious to Kartell agreement.

The industry was one where the process of competition tended to be very expensive. Since capital costs were high, big reductions of price were possible when firms were determined to sell, even if it meant that prices must be close to prime cost; but demand, though it fluctuated violently and thus tended to

precipitate bouts of violent competition, was not, in the short run, elastic, and any advantage from price cutting had to be derived from gains made at the expense of rivals. It has been seen that the succession of new processes, resources and markets which characterised the 'eighties and 'nineties was (save where counterbalanced by such factors as a tariff) unfavourable to Kartellisation, inasmuch as it continuously disturbed equilibrium. But ultimately the increasingly complex structure which emerged out of the flux was favourable to monopolistic association, since, because of it, competition in the more common products grew less and less likely to yield quickly, to any firm, a result commensurate with the expense. The difficulties met by ostensibly low-cost producers in dislodging high-cost rivals, arising out of integration, reputation, and analogous factors, have been described earlier. Such difficulties increased with the age of the industry. The scope for really big reductions of prime cost diminished, the firms without strong resistance disappeared, the kinds of resistance multiplied, and there was a tendency for all firms to try to duplicate within their own structures the forms of resistance enjoyed by rivals. Competition therefore was progressively inclined to end in stalemate; and as this stage approached, restrictive agreements grew welcome,[1] since otherwise the net income of the industry above prime costs was minimised in times of dull trade, reserves were dissipated and indebtedness piled up, and no one in the industry had any significant compensating advantage.

This stage might clearly be discerned approaching in many centres of the industry in the early nineteen-hundreds, which largely accounts for the greater propensity to agreement remarked both in Britain and the States after 1900. The German firms making heavy steel, it has been seen, all had much in

[1] This was quite compatible with a condition in which new plants could be established; it was possibly essential for such plants to have at the outset market contacts—to be integrated forwards, or to be linked with a merchant organisation —and thus to be fairly assured of some sales. Where conditions favoured agreement the entry of a new firm into the industry led to a short period of conflict only, the newcomer being quickly "associated". This happened in Germany with regard to three new semi-product makers in 1900; and it happened with regard to Cargo Fleet and the Railmakers' Association in 1906: *I.C.T.R.* Dec. 21, 1906, p. 2176.

common; and their differences tended to cancel out. In the States it was the same; there were few advantages save its size as a financial unit and its range of products which the Steel Corporation did not share with several rival firms. In Great Britain there was far greater diversity of structure, largely as a result of the changing relative advantages of the producing districts; but even here the particular advantages of individual firms were tending more and more to cancel each other out.

There remains one final problem concerning the history of the monopolistic associations. Why was it that German and American trends were so different, since in both the industry was protected, and in both—quite as much in the States as in Germany—there was an approach to stalemate by 1900?

Until the late 'nineties the marketing problems of the two industries were essentially distinct, and no similarity of structure was to be looked for. While the German industry had already prior to 1880 expanded beyond the absorbing capacity of the home market, the American maker was preoccupied until close on the end of the nineteenth century with the apparently indefinitely expansive home market. Foreign markets were remote and, since the cheapest American production was inland, expensive to reach; they were only spasmodically desired, and they were then supplied by producers working at lower prime costs than were achieved in the States. Dumping abroad had consequently little or no attraction. But it often happened that dumping at home was attractive. The vast demands for standard products along with the concentration of ore traffic on the Lakes encouraged the progressive adoption of mechanical methods, which brought big cost-reductions so long as plants were well occupied. When demand slumped, the firm with the newest equipment—it was often Carnegie's—found that its losses were least (or those of its rivals most) when it reduced its prices so as to run fully occupied. It could be sure that demand would soon "outrun" supply. There were slump years when no firm resorted to this policy, possibly because none was adequately prepared: plant changes might be in progress. At such times price agreements were made and were honoured. But they

were always unstable—merely temporarily convenient, as in Britain.[1] They never obtained any formal elaboration, and were often dishonoured before they were denounced. Your "boys... figured on a ten-storey building instead of eleven" in preparing an estimate for structural steel; or you offered tie-rods or fish-plates free with rails at the association price.[2]

By the late 'nineties the situation was changing. The home market was now, as has been seen, unable to absorb the whole native production, which had responded amazingly to the stimulus of high tariff-supported boom prices. At the same time production costs had come closer to the European level—for the common heavy products there was possibly little difference. But the chance of further notable reductions of cost by the usual American methods was slight.[3] Hence dumping abroad now became more possible and more attractive, while dumping at home became less so. The American situation thus became analogous to the German, though with important differences of degree.

When this happened some approximation of American to German structure might be expected. But the elaborate Kartells of the latter country were ruled out for the States, since monopolistic agreements were subject to sanctions—not merely, as in Britain, unenforceable at law. What actually occurred has been broadly narrated above. Semi-monopolistic consolidations, for whose creation American conditions were more favourable than European,[4] were organised at all stages of production, and all these were combined together in 1901. The resulting Trust controlled varying proportions of the trade in different stages, far more in the re-rolling branches than in heavy steelmaking,

[1] Hendricks, *op. cit.* pp. 182–3, 421–2.

[2] *Iron Age*, Aug. 17, 1911, p. 367: evidence to the Stanley Committee.

[3] Schwab made this clear to the Stanley Committee in 1911; "Carnegie's price policy would not be possible now": *Iron Age*, Aug. 10, 1911, pp. 315–16. Charles Kirchoff reflected the American position before 1900 admirably in interpreting, incorrectly as it appears, the prevalence of Kartells in Germany at that date. No effort was made in Germany, he said—quite wrongly, to get orders to keep full, even though the orders be taken at a loss. He was of course only taking home trade into account. The Germans, he went on, "cannot understand a policy which dictates a rush of orders....This may be partly due to the fact that no one concern nor one district feels its ability to force others to shut down": *Iron Age*, June 21, 1900, p. 17.

[4] Above, pp. 266–7.

but though outsiders were important in some branches they formed only a small group numerically, and thus one suited to informal agreement.[1] In many respects the objects of consolidations were similar to those of the Kartells. The primary objects (apart from the promoters' search for profits) were to raise prices above the existing internal competitive level, and to reduce costs both by adapting the scale and location of production more perfectly to the market, and by reducing competition in selling, and consequent cross freights. (Though the Kartells could not control the scale and location of plants their primary objects were otherwise the same.) Several consolidators also had in mind the possibility of pushing export sales—of using foreign markets to absorb surpluses.[2] Gary indeed said that "the export situation was one of the dominating causes of the U.S. Steel Corporation". Consolidation was needed from this standpoint, he held, because of the great expense involved in selling in markets where European makers were entrenched; but clearly enough the same two-price policy as the Germans used was envisaged and was practised.[3]

Protection, therefore, having first extended the local monopoly of American makers, now allowed and encouraged its exploitation. But success could only come in this policy of exploitation if there were some degree of uniformity in the price policy of all firms. Consolidations alone were not enough. The Corporation, realising this, appears to have used its influence to promote informal price-agreements throughout the industry; and these on the whole were honoured.[4] It was often argued

[1] O'Hagan, *op. cit.* II, p. 315, said that in England an agreement which was not legally enforceable only had a chance of success if the members numbered six or eight at the most.

[2] Cp. e.g. *Iron Age* on the Wire Combine (leader, Dec. 23, 1897, p. 20) and on the Federal Steel Company (Aug. 25, 1898, p. 20).

[3] For Gary's views see his evidence to Stanley Committee, *Iron Age*, June 8, 1911, p. 1405, and Tarbell, *Life of E. Gary* (1925), pp. 91, 111. Gary admitted dumping, denying implications of monopoly price at home.

[4] The subject was discussed before the Stanley Committee. Complete uniformity of prices of different firms was not achieved, but variations were insignificant. There were for a time "Gary Dinners" at which "professional problems were discussed"; e.g. *Iron Age*, Aug. 10, 1911, p. 315. Cp. also evidence to Dissolution Suit, *ibid.* May 1912, p. 1320. Several formal pools were broken up in 1904 because Gary thought them illegal: *ibid.* Aug. 17, 1911, p. 367.

that the honouring reflected mainly the strength of the Corporation, and the danger of provoking reprisals from so powerful a rival.[1] Monopoly was within its reach, it was said, and was only ruled out by the state of the law and of politics. Possibly, however, the facts should be read differently, for the honouring of agreements may have reflected fundamentally the changed market and cost conditions in the States, where competition in quality and services was now perhaps more profitable than competition in price.[2]

4. INTEGRATION

"The keystone to success in the iron trade", it was said in 1873, "was the possession of a good bed of coal."[3] The view was often subsequently echoed. It amounted, however, to little more than this, that the prices of coal and iron did not invariably move in step with each other. John Strain, chairman of both the Lanarkshire Steel Company and John Watson's collieries, explained it to the Tariff Commission with a slightly ingenuous turn of phrase: "It is almost axiomatic that when the coal trade is prosperous the steel trade is depressed, and when abundance of cheap fuel can be had, steelmakers can produce more cheaply: so, continuing both industries tends greatly to a uniformity of profit earning, no matter what the state of either trade." And he added, if both trades were depressed together, "the larger resources of such companies as are coal masters also enable them to keep their furnaces in blast and tide over the dullness."[4]

These commercial advantages of integration with coal were discovered in periods when coal prices were relatively high; and

[1] Cp. e.g. Julian Kennedy's evidence to the Stanley Committee, *Iron Age*, April 4, 1912, p. 887.

[2] There is evidence of competition in quality in relatively common products. The Bethlehem and Pennsylvania Steel Companies, e.g., made nickel steel rails; Bethlehem and the Tennessee Companies pioneered open-hearth railmaking; while Bethlehem was the first firm to introduce into the States the "Grey" mill for rolling broad beams. In each instance a price advantage was reaped: *Iron Age*, Dec. 24, 1907, p. 1903, and May 16, 1912, p. 1324.

[3] J. D. Ellis at John Brown's meeting: *I.C.T.R.* Feb. 1, 1873, p. 648.

[4] *Rep. Tariff Comm.* § 620.

they were emphasised most by firms whose steelmaking was in some difficulty. It was said of the Welsh Bessemer firms after 1900, for example, that "the coal had really supported them".[1] Naturally: they had no other strength. Whether the advantages of integration over a long period for firms reasonably well placed to make steel were very material is doubtful. To obtain cheaply an exceptionally good mine would be an advantage to any firm. But the British coal industry was amply competitive and not in a position persistently to exact prices which yielded high returns save on exceptional mines. Hence, since continuously high prices were unlikely, the astute forecaster among steelmakers stood to lose by backward integration. For while this brought a certain security it removed a chance of speculative profit. And of course it greatly complicated the problems of management. Possibly the professional manager, handling other people's money, preferred to shoulder this latter burden and to avoid the risks of speculation; integration may be psychologically adapted to a world of joint-stock companies, disintegration to a world of private businesses. Whether or no this be so, it is unlikely that the British industry was appreciably weaker in international competition just because many firms bought coal in the open market.

That German and American firms became to an increasing degree owners of their fuel supplies in the 'nineties and later was simply an outcome of monopoly, which was the main factor differentiating British and rival growth in this matter. In the States Carnegie secured control on good terms in the 'eighties of the dominating Connelsville coke concern, the Frick Company, and as a result prices were charged which discriminated against Carnegie's rivals. So the rivals set out to secure coal mines of their own. In Germany the coal and coke Kartells of the early 'nineties played the determining role.[2] Prices of coal in Westphalia were raised considerably, prices on the Baltic and

[1] *Ibid.* § 647. The *Report* also contained instances when steel firms had been for long successful though they had no coal, e.g. § 550.

[2] These Kartells did not have a tariff to encourage them, but drew their strength from the valuable local monopoly which they could exploit. Transport cost was a far greater protection for coal than for iron or steel.

in export and other competitive markets remaining at a lower level. The change put the combined iron and steel and coal firms in a relatively more advantageous position than they had been in *vis-à-vis* the "pure" iron and steel firms, and the latter offset this whenever they could by amalgamating. They were often able to do so on good terms, since there were coal mines outside the Kartell who sold wholly in Westphalia at prices just below the Kartell price, and who did very well, but were yet glad to secure a large and certain market.[1]

The relation of iron smelting to ore mining was governed by conditions largely analogous to those governing its relations to coal mining, and the advance of monopoly in the Mesabi mines was responsible for the chief difference between British and rival developments in this respect in the 'nineties. Schwab, it is true, defended the establishment of the Steel Corporation for this reason among others, that whereas before combining each component firm had been forced to rely mainly on its own ores, since it could only buy ores from the other firms at relatively high prices, after uniting they could obtain those mixtures of ores most suited to economical and uniform working. Ostensibly this was a technological argument for fusion, both horizontal and vertical; but it derived its force from the disturbance wrought by earlier integrations, which gave to the individual component firms quasi-monopolist control of certain grades of ore. Had these earlier integrations involved no technological handicap, the later would have brought no technological gain. There was another ostensibly technological consideration which sometimes counselled integration, which was also, like Schwab's consideration, fundamentally an outcome of monopoly. Some firms had been unable to obtain ore supplies of uniform quality from a single source: it had happened, for example, in Lincoln-

[1] The Coal Kartell was reconstructed in 1905, and the integrated mines came in, but their terms were such that the consumption of coal in their own iron or steel works did not count as quota. Hence it still happened that amalgamation was welcome to both "pure" coal and "pure" iron concerns. For a coal concern was enabled by amalgamation to extend its output without negotiating an increased quota in the Kartell, and, since this often meant reducing costs, a union with an ironworks would be made on terms offering some gain to the latter.

shire. But it was unlikely to occur where the consumer had access to many alternative supplies and there was competition. The practice of careless mining was of course ultimately bound to react unfavourably on the mining company,[1] though this was no guarantee that it would be rapidly improved.

The influences varying the degree of integration which occurred in Britain and rival centres between smelting and steelmaking, and between steelmaking and re-rolling, engineering, etc., have been traced in another context and it is needless to recur to them. That circumstances favoured more integration in Germany and the States is manifest; nevertheless, the linking of smelting and open-hearth steelmaking in Britain would in many places have certainly led to economies, while fusion of re-rollers with steelmaking might in certain contingencies have hastened the arrival of large-scale production. Whether there were unrealised opportunities of advantage in more integration with engineering can only be judged from a knowledge of individual instances, which is lacking.

There is one other cognate problem. Could British firms with advantage have participated more actively in the marketing of their wares? Jeremiah Head emphasised one side of this problem at the British Iron Trade Association's annual meeting in 1894. "It is doubtful", he urged, "whether English makers have done enough to stimulate the use of iron and steel for new purposes. It is at any rate certain that on the Continent and in the United States a great deal more has been attempted and achieved." The second aspect of the problem concerned competitive, not "creative", selling. Was merchant selling, at least in its simplest form, less adapted to new conditions of trade than to old?

Jeremiah Head was mainly concerned with the efforts made by the German industry collectively, and by individual American firms, to popularise and cheapen the use of steel for bridges and for buildings. The German Ironmakers' Association had com-

[1] It is said that a well-known firm decided in the 'twenties not to make Thomas steel in Lincolnshire because the ore, which it did not mine, was well graded. For early references to careless Lincolnshire mining, *J.I.S. Inst.*, 1876, pp. 332, 336.

bined with the Association of Architects and Civil Engineers to assemble and publish information which should advance the new technique; they believed their efforts increased the business.[1] Some German integrated steel firms also became individually noted as designers of structural works, but Head was more impressed with the outcome of this in America than in Germany. Carnegie's in particular had been able to reduce costs by standardising practice in skyscraper building; and other firms had advanced along the same line.[2] Possibly collective action on the German model would have been valuable in Britain, and its absence may reflect the forces which delayed the coming of standard sections. But the steelmakers were not alone responsible; constructional firms and civil engineers may equally well have been obstructive and unimaginative. Together these groups might doubtless have done much; among other things they might have persuaded the local authorities who imposed building restrictions to look with less (and uniform) suspicion upon the new material. As to advance by individual firms, it was probably true that had British constructional engineering firms—integrated with steelmaking or otherwise—normally designed the structures they made (submitting designs to a buyer's consultant) instead of working to the designs of an independent civil engineer from Westminster, there would have been some useful adaptation of design to the process of manufacture,[3] and less premium on idiosyncrasy. And there was perhaps some failure throughout the constructional trades to employ trained engineers.[4] At the same time the American field, and the German too in a smaller way, gave far more scope than the

[1] *Ibid.* and *Stahl u. Eisen*, Nov. 28, 1935, p. 1329.

[2] E.g. the Pencoyd, who successfully tendered to the British government in 1899 for a bridge across the Atbara (Sudan). The bridge was required quickly in order to allow Kitchener's campaign to proceed according to plan, and the Pencoyd Company, with a standardised plan, was able to guarantee rapid construction while British firms could not: *Iron Age*, March 23, 1899, p. 23.

[3] The point was very commonly noted, e.g. by du Riche Preller, *Engineering*, Jan. 27, 1897, pp. 96–7 and by R. S. Ball, *ibid.* 1899, p. 713. The types of economy were the use of a few sections, and standard spacing of rivet holes. Greater speed in designing and erecting could be achieved.

[4] Above, p. 262, n. 4.

British for mass-production methods applied to these trades. The innovations of Carnegie's, by all accounts, were not recondite in type. Moreover, the profits from steelmaking in boom periods in the States gave far more financial strength to an integrated firm like Carnegie's to advance its constructional trade than any British firm could have enjoyed. It is noteworthy that the leading British constructional firm of the early nineteen-hundreds, Sir William Arrol's, employed its own designing staff, but was unintegrated.[1]

The second aspect of the selling problem is the more generally important. Could British firms, by adopting a different selling policy and organisation, have sold more steel at a high price, or reduced selling costs,[2] or have so enlarged the volume of their sales as to allow lower manufacturing costs to be achieved?

In retrospect it appears likely that in the sale of high-grade steels the employment of salesmen who had a long technical training and experience would have helped. The Germans led in this kind of thing. Occasionally, around 1900, technicians from British works were sent out on special selling expeditions, but there were no technicians in Britain, as there were in Germany, whose whole job was to sell. The technician-salesman was better equipped to justify a high price, and to point out what might be gained by paying more than a competitor's price, and he was able also to demonstrate the correct use of a material—to show, for instance, the correct heat treatment for a steel used in the manufacture of a cutting tool. Although, however, this is now recognised as important for the sale of alloy steels, it is highly improbable that such methods could have affected the sale of common-grade steels. It is likely indeed that British salesmen made out the case for acid open-hearth steel as against Bessemer and basic steels with a flattering success; and, apart from the broad differences due to process,

[1] *Engineering*, May 13, 1904, p. 482.

[2] This is, of course, an ambiguous phrase, and I use it here with reference solely to direct expenditure on selling. But clearly if a greater expenditure per ton leads to sales at a higher price the net result might be regarded as a lowering of selling costs, and the phrase would also be misleading if the additional expense led to greatly increased sales and reduced manufacturing costs.

in the bulk trades the variations in character of "carbon steels" were not closely investigated. It would be a mistake to confuse the post-war and pre-war position in this respect.[1]

In retrospect it also appears that some British firms might profitably have combined their forces for selling in markets where sales expenses were high (where for instance the Ministers of State of an importing power had to be lavishly entertained) and where higher prices were to be obtained if the mutual competition of British firms was absent.[2] Here again it was the trade in high-grade steels which was mainly involved. In the common-grade trades the reduction of selling cost by co-operation would have been small, and easily offset by the cost of co-operation and the handicaps which it involved,[3] while prices were probably governed very largely by foreign exporters' levels. For the Germans it was otherwise. Their large firms, restrained by Kartells from competing at home, "waged epic fights in foreign fields" (against each other) and brought prices down to a point far below that set by foreign competitors.[4] Thus the Stahlwerksverband was able to raise export prices without lessening sales. But for British firms this was scarcely possible. There was another form of co-operation, however, which German firms adopted, which might have helped some British firms in the common-grade trades. The British Iron Trade Association delegates of 1896 attributed a lot of German exporting success to the "energy and enterprise shown by syndicates organised for the extension of foreign business". It instanced one, the Syndicate of Engineering Workshops and Metallurgical Establishments, formed by seventy-three firms, and representing only one house for each branch of trade, which organised

[1] On the gains through expert selling in high-grade steels I have had information from firms concerned, and Sir William Larke has often emphasised it (e.g. Balfour Committee, Minutes of Evidence, Q. 6274). The German lead in this was recognised by 1900 by the American consuls, and implicitly by some British merchants who quoted them (cp. W. Jacks, in *Trans. Glasgow and West of Scotland Inst.* 1902, p. 12).

[2] The sale of armaments is the most obvious instance, but not quite isolated.

[3] Which have been surveyed earlier, above, pp. 276 sqq.

[4] The phrase is from Sayous, *op. cit.* p. 203. The point was emphasised before the Kartell Inquiry. Cp. *Kont. V. u. d. Kartelle*, IV, p. 291.

permanent exhibitions of members' products at important centres in the Near East; another similar syndicate was operating in Central and South America, organising travelling exhibitions. Something of this kind might very probably have assisted British exports in some markets.[1]

But could it have succeeded in those trades where British costs were high? Could it have enabled British firms to extend sales and thus lower costs? Skelton the merchant held that British firms got higher average prices for common-grade steel than German firms, yet it was the Germans who paid the more regular dividends.[2] Could the position have been changed by changes in selling technique, or must the first change have been on the side of production?

There are important British firms whose present leaders ascribe much of their own success to sales policy. "Most British firms", they say, "make no effort to sell their steel." And it is possible to discover firms who to a surprising extent wait for orders to come to them, who have no commercial travellers, and, if they advertise at all, do so (they will readily admit) in the oddest of places. But it is noteworthy that the firms who wait for orders are neither well placed nor well equipped for any save local trade; those which have adopted more vigorous selling methods have had, for one reason or another, low production costs. Lysaght's and Stewarts and Lloyds', for instance, quite early had the great advantage of cheap imported semi-products; Whitehead's was the first British firm to exploit the scope for continuous bar mills in Britain. Hence in all three instances sales organisation may be regarded as a response to low costs. Given low costs, then the relative selling efficiency of a firm in the common-grade trades was a vital factor in its further growth, and thus in the further reduction of its production costs.[3] But also, given low costs and

[1] *Rep. B.I.T.A.* 1896, pp. 17–18. The view was often expressed. E.g. Sir E. H. Carbutt at the British Iron Trade Association in 1898, quoted in *Engineering*, May 6, 1898, p. 569.

[2] Letter in *I.C.T.R.* Dec. 18, 1903, p. 1779.

[3] In the first two instances, low costs were not peculiar to the particular firms, but common to all firms making the same kinds of product. The sales policy was therefore a factor differentiating these successful firms from others.

low prices, British merchants appear to have sold quite successfully. There was enterprising merchant-selling in the galvanised sheet trade by the late 'eighties;[1] the expansion of the tinplate trade was brought about wholly by merchants; and British merchants handled a surprisingly large tonnage of Continental steel exports to overseas markets in the late 'eighties and early 'nineties, and some after 1900, though the scale cannot then be traced.[2] Indeed much of the makers' dislike of "merchant-selling" was due to this successful handling of Continental steel, as a war-time report drawn up by makers showed. "The weak point of British commercial structure...has been the free merchant. Through him competitors could establish a footing in overseas markets."[3]

To sum up, then: the available evidence, which is slight and can only provide a provisional conclusion, suggests that the relative decline of the British trade in common-grade iron and steel products was not due in any significant degree to faulty selling technique. When a single manufacturing firm was in a position to dispose regularly of a very large tonnage of material in a particular market it became valuable to have special representation there; an exclusive agency or a branch house. But special representation could not bring business if the firm's products lacked essential "selling points". There may be some truth in the assertions that "it is easier to make steel than to sell it", and that "many a steel firm has been made by its London

[1] E.g. the Liverpool merchant house of John Birch published a booklet describing the use of corrugated and flat sheet iron, with directions as to tools, costs, etc.: *I.S.T.J.* July 6, 1889, p. 12.

[2] The tonnage of Continental steel re-exported from Britain averaged 85,000 tons in the period 1886–90 and was never below 67,000 tons; it was mostly bar iron and steel. It went to many markets, the largest single customer being India. The average price when re-exported was above the average price of British bar. After 1892 the tonnage declined, but British merchants handled sales of material which never came to England at all. Evidence of this is indirect and not statistical, e.g. in 1904–5 Thyssen's supplied a British merchant with plates for Japan. It was subsequently discovered that the test pieces supplied to Lloyd's officials at the works were subjected to heat treatment after being sheared from the plates and before delivery for tests. The plates were faulty, and the case came before the courts: *I.C.T.R.* Nov. 24, 1905, p. 1793.

[3] *Report of Departmental Committee of Board of Trade to consider the Position of the Iron and Steel Trades after the War*, 1918, XIII, p. 439.

agent";[1] nevertheless, at this time a change in the productive structure of the industry was the essential first step to retaining common-grade trades, save where cheap imported semis could be used. After that, a modification of selling practice might have been justified, and even necessary.[2] Divergence between British and German structure in these points can thus largely, though not wholly, be explained by environment. Factors which favoured the emergence of giant firms and cheapness of production in the bulk trades in Germany favoured also a more intimate participation of makers in selling. The large scale and wide ramifications of some of the merchant and transporting firms led to the same result by a different route;[3] while the adaptability of conditions to Kartell growth naturally allowed makers to exert a far greater influence over merchants than was possible in Britain, and to eliminate the merchants' influence over prices while retaining and monopolising their services as intermediaries, as stockholders, as suppliers of circulating capital, and as organisers of the sale of small lots.[4]

[1] Skelton, *op. cit.* p. 545.

[2] It is significant in this context that as Richard Thomas's grew more important in tinplate making it drew large sums of new capital from merchants, which suggests a mutual association of interests. E.g. an issue of new shares (amounting to about £20,000) in 1912 was entirely taken up by two partners in a firm of tinplate merchants, H. and S. J. Burrell Prior. Already by 1900 F. W. Bond, among other things a tinplate merchant, was a director of the firm.

[3] Above, pp. 227–8.

[4] It is not of course argued here that the familiar criticisms of British salesmanship in foreign markets were all unjustified. The records of salesmen who had to give secrets away to intermediaries through their lack of linguistic accomplishments, of firms who repulsed complaints—"How quite impossible; we have never had a complaint before", of firms who insisted on quoting prices for foreigners in English money for English measures, of firms who packed goods carelessly and unsystematically, and so on, all have an air of verisimilitude. All that is argued here is that it is doubtful whether all this has much relevance to the bulk steel trade. The literature on marketing, it is important to recognise, is almost all written by critics, anxious to find gaps. Most of it originates from consuls—British, French or American. It has never been carefully sifted; and successful elements in British selling practice have never been sought out and written up. It is highly probable that though German selling was more actively persistent than the British it was less tactful.

5. THE PERSONAL FACTOR

"Are the directors the enterprising men here? I leave that for you to answer."[1] The questioner was Pilkington, manager of Sheepbridge; his audience was a meeting of South Staffordshire managers. The answer he thought it needless to voice was the refrain of numberless discussions in the industry as the old century gave way to the new. "In Great Britain", Windsor Richards lamented, "there is always hesitation. British manufacturers must not be so slow in the future as in the past."[2] "I have a suspicion", said Ebenezer Parkes, M.P., a prominent Staffordshire ironmaker, "that perhaps we have not sufficient pluck in this country...in scrapping old and effete plant."[3] (He had himself just started a new works whose power unit was an old beam engine reassembled on a new site.) James Riley, honoured technical pioneer of the Scottish industry, deplored "the want of confidence, and the passive resistance often met with, which stood in the way of change".[4] Charles Dorman "ventured to say that the masters...were not very full of brilliancy. There was no reason why, if we infused a spirit of energy into all our operations, we should not do just as well in our mills as the Americans."[5] Selby Bigge, protagonist of electrical development in the industry, found that "in England people made changes when driven by absolute necessity, not out of enterprise".[6] Walter Dixon, the Scottish iron smelter, discovered that "we take as long to see the advantage of an American advance as they to see its faults. We cannot succeed at a jog-trot pace."[7]

There were other critics who extended the accusation of lack of energy and enterprise to non-technical elements of the industry's development: who found the same faults in selling as in producing. This has already been illustrated; a remark of Sir Rennell Rodd's in a report on our commercial relations with

[1] *Proc. S. Staffs. Inst.* XVIII, p. 30.
[2] *J.I.S. Inst.* 1897, I, p. 107.
[3] *I.C.T.R.* April 10, 1903.
[4] *J.I.S. Inst.* 1900, I, p. 23.
[5] *Colliery Guardian*, Dec. 27, 1901, p. 1371.
[6] *J.I.S. Inst.* 1902, I, pp. 246–7.
[7] *Ibid.* 1901, I, p. 108–9.

Egypt was wholly typical: "If British houses would only devote an energy and enterprise similar to that displayed by other nations...."[1] There were other critics again who diagnosed in addition to lack of energy and enterprise an unduly acute individualism. "We are divided up more than we can remain if we are to hold our place...we work too much by individual effort...we could do better by hearty co-operation."[2] Ironmasters were said to be only less individualistic than cotton manufacturers, their long resistance to co-operation in wage negotiation[3] and the late acceptance of standard sections being instanced as proof.

The value of these comments is hard to assess. They were sometimes no doubt the result of shock, often a sign of frustration, always propagandist in intention; their authors did not aim seriously at precision in their analysis. They are noticeably lacking in discrimination, and in particular they jumble together the effects of inadequate intelligence and training and the effects of inadequate effort.

That there was inadequate training has already been emphasised, and it was bound to have a cramping and even paralysing effect, and to limit seriously the field for energy and enterprise. The British makers were less well equipped than their rivals to judge the commercial prospects of innovations while they were in an experimental stage, or to forecast the trend of technical change and therefore to be prepared for it. Thus it must often have occurred in Britain, when changes were proposed, that the "man of judgment" was the man who suspended judgment, who in effect adopted traditional methods, shaped his investment policy according to the shortness of his views, and adopted novelties after the cream had been skimmed.

[1] Quoted in *Econ.* April 15, 1896, p. 483.

[2] *Proc. S. Staffs. Inst.* XVIII, p. 152–3.

[3] *Engineering*, June 23, 1899, p. 817. It may be remarked that there was less agreement that individualism was too acute in Britain than that enterprise was lacking. Individualism was widely recognised as a characteristic of the British industry, but many observers thought this was a strength, a sign of life. On the whole the leader writer in *Engineering* took this view, though not with regard to wage negotiations.

How much lack of enterprise was to be explained this way, and was not derived from a more fundamental deficiency, cannot of course be known. It is significant that, though the critics were silent about it, the British industry manifested many signs of enterprise, though not at all points. The setting up of new small works and the development of the sheet and tube trades obviously required initiative and energy. Even the setting up of new though old-fashioned bar-mills in the Midlands for a local market was a token of enterprise of a kind. And the history of firms like Dorman Long's and the Furness group show enterprise on a fairly large scale, which was bold if not always happily conceived. In so far then as there *was* a striking lack of enterprise in the British industry which was not merely an outcome of inadequate training it was scarcely manifested universally in the industry, but was concentrated in some branches and in firms of a particular type: namely, the older among the big firms.

Probably most of the critics would have accepted this limitation. Such at any rate is suggested by their attempts to account for the deficiencies and disparities they discovered. For apart from the lack of training, the explanations suggested were differences of climate, the relatively high average age of the dominant personages in the British industry,[1] the greater influence in Britain of "rich men's sons"[2] and the "indolence and apathy often engendered by phenomenal success".[3] The explanation by climate was not in fact very widely advocated, though it had the support of distinguished authority—it was, for

[1] E.g. Walter Dixon, *J.I.S. Inst.* 1901, I, p. 122: so long as elderly and old men were retained at the head of our concerns, it was doubtful how far we could maintain our position, with other disadvantages around us.

[2] The phrase was specifically used by the merchant Skelton, ostensibly quoting a German critic. Cp. *I.C.T.R.* April 10, 1903.

[3] The phrase was du Riche Preller's, in *Engineering*, Jan. 27, 1893, pp. 96–7. Cp. also Oppenheimer, in a consular report from Germany: "Germany, with the problem of English competition from the start, has introduced new tactics and artifices...which will have to be adopted by the older English exporting houses if English industry is to compete on an equal footing....Now, the prophet must go to the mountain." Quoted in *Econ. Monthly Trade Supplement*, Oct. 13, 804, p. 9.

example, sustained by the economic historian Ashley,[1] who at least had a right to speak derived from residence in two of the climates concerned. The thesis is not unreasonable, although obviously it is hard to prove, that the damp-laden atmosphere of Britain leads to a certain lethargy of habit or temperament. If true, there would of course be a universal, not a selective, effect. The other forces, more popularly suggested, on the other hand, were such as would have a limited and sporadic influence. The domination of old men and of men who became important by inheritance, and the inactivity bred by a sense of security which was originally derived from monopoly, were characteristics likely to be found, if at all, in long-established firms which had a record of success behind them.

The fact that the deficiencies they diagnosed were aggregated in particular parts of the industry was thus consistent with the critics' analysis. And it will be remarked at once that their criticism gains in credibility and substance from the analysis of causes with which they accompanied it, albeit that analysis was on the whole casual and commonplace.

Clearly it was to be expected that the British industry would have a higher proportion of old men and of rich men's sons in important positions than the German or American industries[2] —since in its modern form it was the older industry, handicapped by a relatively inexpansive market, and for these reasons more affected by the development in firms of diversification, integration, and the like, and therefore, as shown earlier, a less favourable field for new firms to rise quickly to importance. It was further to be expected that age and nepotism based on capital accumu-

[1] Reported in *I.C.T.R.* April 10, 1903. He was sustaining the view that "although their (America's) ablest men are not more alert than our ablest men, there is a greater diffusion of quick intelligence and the spirit of enterprise among the people of America than in this country". Climate and social conditions were his clue to this.

[2] There are no statistics on these points, but the facts were not disputed. The situation was bound of course gradually to change, and the British disparity to disappear. A recent rather cursory survey suggests that the average age of directors is still two or three years below the English figure, while the proportion of very young and very old directors is much greater in the States. Cp. Campbell and Miller, *Financial Democracy*, p. 100.

lations would have the sort of effects that were suggested (that is to say, would lead to a deficiency of enterprise and energy), though here it is easy to exaggerate. Some of the most fervent supporters of innovation in the late 'nineties had been defenders of caution in the 'seventies: Jeremiah Head was an impressive instance.[1] But the view that age brings with it a growing conservatism and a diminishing adaptability, and reduces both the will and the physical power to undertake great ventures in unfamiliar territory, is almost certainly justified; and there is a probability, too, that when fortunes had been made they would provide an additional motive for a slackening of endeavour, or at least the avoidance of new endeavour. As early as the 'seventies a German spoke expressively of the Scots ironmasters as "reich und etwas schwerfällig geworden". Charles Dorman's complaint that in this country, by contrast with the States, "if a young fellow of thirty-five makes a suggestion he is told to go and teach his grandmother to suck eggs, or alternatively that his suggestions were tried fifty years ago"[2] has an air of verisimilitude. The corrupting influence of fortune (from the most narrowly industrial standpoint) was of course bound to be greater in the second and third generations of an industrial dynasty than in the first. Where wealth and a position of leadership came by inheritance the urge to concentrate on business affairs was less than when a business was being built up. There were ample signs of this in Britain in the late 'nineties. Jeans pointed in 1902, with an obvious implication, to the long working hours of responsible partners and managers in American works;[3] he could have done the same with regard to the Con-

[1] In 1871 (when he owned a mill) he was urging that "it was quite impossible to take up all the numerous systems which were offered to their notice...and the greatest caution was necessary before deciding to supersede by a novelty any machine which was doing its work fairly well". Twenty-five years later (when he was a consulting engineer) he was proclaiming that "Nature in her economic laws, as well as other laws, is inexorable, and if we were to retain our position in the face of competition...we must keep up to date, whether we liked it or not": *J.I.S. Inst.* 1872, p. 94, and 1897, I, p. 113.

[2] *Colliery Guardian*, Dec. 27, 1901, p. 1371.

[3] *Amer. Indust. Compet.* pp. 74–5. They started work at 8 o'clock. It should be noted, however, that even old family firms, such as Baldwin's, the locomotive manufacturers, supplied illustrations for Jeans' theme.

tinent. And in many family firms the habit of using up resources extravagantly for social and political purposes was an embarrassment to the staffs who were running the works.[1] Nepotism was likely to have another important influence. For an industry where the best positions tended to remain in family circles would hold out little attraction for the most enterprising young men as recruits; there was likely to be a dearth of invigorating new blood in the industry even where there was room for it.[2]

Support for the critics' views on the effects of family influence in the industry may now be drawn from American experience. Among the family cotton-mills of New England it has been noted that "in some cases there has been a tendency for the family to expect regular dividends whether currently earned or not, and in their payment surplus has been exhausted, leaving no funds for needed investment in new equipment". Again, "in the opinion of many observers there is a pronounced reluctance to hazard new methods in old industries that have been reasonably successful, and the management of which has continued in the hands of the same individuals or the same family for long periods".[3] At the same time it must be recognised that in most countries there are impressive instances where these anticipated consequences have not occurred; that some stocks have been enterprising for several generations, some old men extremely adaptable and energetic, and some families reinvigorated by careful marriage alliances.

[1] I depend here on private information. By "political purposes" I refer to expenditure incurred by the holding of political office, not expenditure with a view to promoting a firm's industrial interests.

[2] This is a point which is obviously not likely to be referred to often in published records. A remark of Edward Williams as early as 1879 implied a difficulty of obtaining recruits of sufficient ability: "It seems to me much to be desired that educated intellectual young men, who now hang listlessly about the professions and so-called genteel occupations, which promise to them at best only respectable poverty with the more than doubtful advantage of leisure, should break through the absurd old prejudice against seemingly rough work, and come over to the healthy business of iron and steel making": *J.I.S. Inst.* 1879, p. 24 (Presidential Address).

[3] H. Jerome, *Mechanisation in Industry* (1934), pp. 335, 355. Much of this book is valuable as a corrective to popular simplifications of American conditions, and, more generally, for the comparative study of industrial growth.

Indeed, it may be easy to exaggerate the influence of age and of succession by neglecting, as most of the contemporary critics did, other influences which might have analogous results. In the first place, so long as the obstacles to radical changes in Britain, which were greater than elsewhere, were not overcome, the general condition of the British industry was less stimulating than that of the rival industries where the lesser obstacles were earlier surmounted. Garrett, the American rolling-mill expert, told an incredulous British audience in 1901 that "the chief trouble in England was lack of competition".[1] It was a penetrating remark. Had one British firm or group made radical changes, others would have been forced to follow; latent powers would have been drawn out. But the initial impulse was lacking. In Germany a few men, most noticeably the newcomer Thyssen, clearly forced the pace; and in the States it was the same. In Britain, more than elsewhere, "it required the advent of some Napoleon of organisation"[2] to provide the impulse, and he was not forthcoming. In the second place, where market growth did not readily allow single plants to expand, it might often be to the advantage of members of the technical staff of a plant not to advise a policy of amalgamation since it might destroy their jobs; they might well be influenced, by a merely half-conscious recognition of their interests, to emphasise all that could be said in favour of the *status quo*. Where the head of a family business was not a highly qualified technician, and in a joint-stock company where the managing director was the sole director with technical knowledge, this influence might be extremely important; and so long as conditions were of the kind that an enterprising policy, while from most standpoints advantageous, was not incumbent on firms, it could be effective for a long period.[3] In the third place, where the capital of a firm was drawn from one or a few families who retained in it for this reason a controlling influence, it was possible that other investments of the same family or families might be lessened in value

[1] *J.I.S. Inst.* 1901, I, p. 108. [2] *Engineering*, June 23, 1899, p. 817.

[3] I have had verbal evidence of this, though I know of no early printed source. For a recent impression see a letter by Henry Summers, *The Times*, March 17, 1934.

by a policy which would be advantageous to the firm. Evidence of this around 1900 is lacking, though it exists for a more recent date; but there is little reason to doubt its influence at the earlier date, particularly in Scotland, South Wales, and in the West Coast hematite district, regions where migration was important.[1] Wherever a firm was strong enough, through its goodwill, specialities, and the like, to hold its own without radical change, then the investments which its chief owners had made locally in land, houses, or the distributive trades, or a local railway, might very well stand in the way of any policy which involved the movement of the business to another site. For this was likely to take business from the railway or population from the estate, or business from the stores. In some measure this mingling of financial interests mirrored the social implications of industrial migration far better than did the capital interests of a firm lacking local investments. But there was no reason to suppose it would mirror the general social interest accurately, or that it would form the basis for a judgment socially sound. Within the industry its manifestation would rightly be regarded as a lack of energy and enterprise. A rather similar result is produced when the policy of a firm is determined by personal, not financial, interest in a locality. The motive is, in a measure, worthy, but the narrow angle of vision may well be inimical to national welfare.

The personal deficiencies in the British industry, apart from those arising out of inadequate training, can be so persuasively expounded as a natural occurrence in an old industry with a slowly growing market that it may be tempting to look no farther. But this is probably not the whole story. For between the time when most of the dominant families in the British industry secured their positions and the year 1900 the qualities required in the industry had changed. Obviously the technical problems needed to be handled in a different way; but this was

[1] There were also, it may be noted, influences in the other direction. I have been told of an instance where an ironmaster used his dominant interest in a local railway to give low freights to his ironworks, a policy which was said to be harmful to the financial interests of the railway.

not the whole of the difference, for the growing advantages of integration posed more severe problems of co-ordination and of staff selection, marketing was far more complex, and skill in industrial diplomacy, in handling relations with rival producers, became important. Professor Hadley pointed this out, narrowly and in a rather contorted form, when addressing the British Association in 1890: "The future Smiles will write 'The Lives of the Market Riggers', or 'The History of Trusts, Syndicates and Corners'."[1] Now it is possible that many of the founders of the older British firms had not the kind of ability required at the later date, and that their descendants lacked it too; that the deficiencies of 1900 were not so much a result of the influence of *family* in the industry as of the influence of the wrong families.

The information required to establish this is lacking. It is, however, possible to indicate circumstances where the selective forces bore no obvious relation to the requirements of the industry in the late Victorian days. It was, for instance, purely accidental if a family whose influence in the industry depended on the chance possession of ore-bearing lands[2] should also possess in a high degree the accomplishments required of leaders of the industry—this was of course true at any stage of the industry's history, though truer as the requirements became more exacting. It was also accidental if a malleable ironmaker, who had risen from the ranks as a roller and from his ample earnings under the contracting system set up a plant of his own,[3] possessed the diplomatic skill or scientific turn of mind which—one or both—were required of an effective ruler of a large efficient concern in 1900.

Furthermore, the slow penetration of the industry by scientists and the grudging, inadequate aid given to technical education are consistent with the theory of inappropriate selection. Professor Sexton at Glasgow accounted for the slow advance of metallurgical education by the failure of iron and steelmakers

[1] Quoted in *Engineering*, Sept. 19, 1890, p. 344.

[2] There are many instances; among the best known of the late nineteenth-century landowner ironmasters may be mentioned the Earl of Dudley, the Cavendish family (Barrow) and the Earl of Granville (the Shelton and Lilleshall works).

[3] This was said to have been common.

to supply the necessary funds, and the failure of works' managers to take trained men.[1] These were certainly signs that the new needs of the times were inadequately appreciated, which might betoken faulty early selection. But since this attitude to training and the trained man was common to most industries, it may manifest a more fundamental weakness. Matthew Arnold had identified in Mid-Victorian days as "our great intellectual fault" an "indisposition to science—to systematic thought", which our school system did nothing to counteract.[2] It is unlikely that the slowly improving school system had counteracted the fault at all completely by the close of the century; perhaps such a deficiency —supposing it properly diagnosed—could never be fully counteracted. The "incapacity for science" which Arnold had also found in the product of even the best schools[3] could, of course, be largely removed, and was notably declining. But it is arguable that there was—and is—little native inclination to handle affairs, industrial or otherwise, on scientific lines, so long as it was avoidable. The worship of compromise, of common sense, of "muddling through", may all be regarded as tokens of this; it is hard to criticise a politician more effectively than by dubbing him (often improperly) an intellectual. In so far as there was a deficiency here, Britain was less suited to the pioneering of industries in the new highly technical phase of development than in the preceding phase; and the "personal factor" differentiating British and rival growths in the iron and steel industry must be explained not solely by reference to circumstances particular to this industry alone, but on a broadly national or racial basis, the industry being the most important of those which felt the effects of a national weakness when least had been done to offset it.

[1] *Trans. Glasgow and West of Scotland*, 1902–4, p. 53. It is of interest that, while the State was very active in Germany in promoting education, the industrialists also took an active part. E.g. at Bochum there were by 1880 schools established for the training of foremen both in the coal and iron industries; young men were selected after four years at a works and given a 1½ years' course of training. The masters supported the scheme with scholarships in proportion to the number of men employed: *J.I.S. Inst.* 1882, p. 390, quoting *Stahl u. Eisen.*

[2] Matthew Arnold, *Higher Schools and Universities in Germany* (1874), p. 217 and *passim.*

[3] *Ibid.* p. 207.

Chapter XII

"THE RIDDLE OF THE TARIFF"

"It is the fashion to make much of the differences among economists", wrote *The Times* in 1902, supporting, in a leader, Alfred Marshall's plea for an Economics Tripos at Cambridge. "These differences and this uncertainty hide only from the superficial observer the value, indeed the increasing value, of the study of the wealth of nations. Never perhaps were the charlatan, the quack and the adventurer in this field in such force and with such effrontery as now....There is need, as there rarely was before, of a scientific reserve likely to stem rushes of ignorance and enthusiasm, and not to be swept away by popular stampedes."

When after the lapse of a year the chief adventurer was Chamberlain, a different tune was called, and a letter sent to the journal over the signatures of most of the leading British economists (among them the erstwhile "high authority" Marshall), expressing the views that a little tariff would be the prelude to a big one, that tariffs were always associated with political jobbery and corruption, that rising imports do not necessarily mean rising unemployment, and that a food tax would lower real wages, gave occasion for an exhibition of *The Times*' versatility. "There was really something pathetic in the spectacle of these fourteen dervishes emerging from their caves and chanting in solemn procession their venerable incantations against the rising tide of inquiry." Outside the "charmed circle in which they wield a conventional authority...their chief claim to attention was the oddity of their garb and the archaic character of their speech". They were not even "consistent with other very eminent teachers of their science", and "the public were forced to perceive how great a part of political economy consists merely of personal appreciations of complicated phenomena and obscure tendencies". "A more scientific con-

ception of their own science," the leader concluded, "which pretends to be but never is an experimental science, would save professors from the painful discovery that they convince no one who stands in need of conviction."[1]

A year later the Tariff Commission's Report on the Iron Trade came as an object-lesson for the professors. Here was "economic science in the true sense of that much abused term": something quite divorced from the "verbal arguments and dialectical devices" of the Free Traders. Chamberlain's friends had issued questionnaires, scrutinised answers, asked more questions, and examined witnesses. If the well-known Free Trader ironmasters had not been examined it was presumably a sign of their own obstinacy; it scarcely deserved notice, and it did not receive it. "We had the indispensable scientific basis of induction, a wide and impartial collection of first-hand testimony as to facts." Unlike "current political economy, which took no note of modern industrial methods (hence the barrenness of its speculations)...the Commission dealt with things as they actually happen in the actual industrial conditions of the age in which we live".[2]

It was probably true that economists did not move sufficiently with the times. How far is it likely, in the light of the information which has now been surveyed at length, that a greater acquaintance with modern conditions in the industry most discussed in the tariff controversy (the industry, according to one party, most immediately threatened with ruin) would have, or should have, affected their judgment on the Reformers' proposals?

No economist elaborated his conclusions on the problems of the steel industry more formally than in a review of the Tariff Commission's Report.[3] But the opinions which prevailed among them are easy to trace from incidental references,[4] and though

[1] *The Times*, April 18, 1902 and Aug. 18, 1903.

[2] Leader of July 21, 1904; but the second quotation is from Aug. 7, 1903.

[3] S. J. Chapman, in *Econ. J.* 1904, pp. 617–25.

[4] In addition to Chapman's review, I have depended mainly on A. Marshall, *Fiscal Policy of International Trade* (1903) in *Official Papers*, pp. 365–420, and A. C. Pigou, *Protective and Preferential Duties* (1906); but I have also used an extensive collection of articles and reviews on the controversy made by Marshall and now in the Marshall Library at Cambridge.

the seriousness with which these were considered is not always clear they nevertheless express the Free Trade standpoint at its best, and provide a convenient approach both to a discussion of the case for State action in defence of steelmaking, whether by tariffs or otherwise, and to a characterisation of contemporary discussions. It may be observed that the casualness with which the subject was treated is in itself not without significance.

Speaking very broadly, three main lines of thought may be distinguished, and all were in some degree vitiated by misconceptions of conditions.

First, destructive dumping was held to be improbable in the international trade in steel, for a reason that has already been explained; namely, that international Kartells were unlikely in the near future, and in their absence destructive dumping directed by one of a number of groups of competitors against another group could not profit the aggressor, since it would not result in ultimate monopoly profits. In retrospect it is manifest that the prospects of international agreement (which was much in the air on the Continent in 1901–2)[1] were misjudged. True, the international Kartells which were established in the early nineteen-hundreds, starting with the rail syndicate of 1904 in which British makers participated, were for the most part limited in scope and primitive in form, the rail syndicate alone establishing some degree of price control. But the reasons for supposing that international agreements, like national agreements, would grow more effective, were stronger than those for supposing the reverse. The forces which favoured the advance of association might readily operate internationally. For instance, the circumstances of all producers who used the minette ores were in so many respects alike that persistent price competition was bound to become recognisably wasteful. Moreover, the strengthening of national associations at once augmented the need for international agreements and facilitated their negotiation. These points escaped observation, partly owing to a second misjudgment, which was well-nigh universal, the assumption that American steel exports to Britain would grow.

[1] Cp. e.g. Sayous, *op. cit.* pp. 310, 318–9.

American costs—both of manufacture and transport—were probably far too high to allow a constant trade with Britain to be attractive or even remunerative; as transport costs were rising, the position grew progressively less favourable.[1] Hence although it was true that there were formidable obstacles in the way of agreement between American and German makers, it could not be assumed, as economists were inclined to assume, that American competition would provide a continuous check on German prices should British manufacture, in some branch of steelmaking, be eliminated. Not that such elimination was considered likely, for—a third misconception—there was a persistent inclination among economists to regard dumping as mainly spasmodic. They were far too wary to bind themselves to this view, and they provided arguments of a kind to cover conditions when dumping was continuous; but they did not seriously examine the possibility that dumping might prove to be destructive, not as the result of a deliberate policy, but incidentally, owing to a chronic tendency to increasing overcapacity which was probably inherent in the German circumstances, and whose bases have been considered earlier. If monopoly prices might ultimately result after destruction, proof of destructive motive was not relevant or necessary. As the economists neglected the price history which would have illuminated this problem they missed the significance of a vital economic force.

The second main line of thought which may be distinguished was that the steel industry was passing through a "natural" transition. There were two branches to the argument. Some relative decline in the importance of British steelmaking, it was held, was to be expected as other peoples developed their resources, and an absolute decline in some branches since British ore resources were being worked out; there was likely to be, for both reasons, a concentration on high-grade rather than on crude products. Employers had cried "Wolf" in every depression since 1866, but there was no clear indication, in view of the distribution of mineral resources, that what was happen-

[1] Ripley, *op. cit.* p. 534.

ing in the early nineteen-hundreds was more than should be expected in the normal course of competition, still less that it was catastrophic. On the contrary the amount of new investment in the industry, above all the fact that such big consumers of steel as Christopher Furness and Arthur Keen and the firms of Nettlefold's and Baldwin's threw in their lot with heavy steelmaking at this time, suggested the reverse. If, then, in the course of competition some branches of British steelmaking were eliminated it would be quite healthy; it would show not a general debility, but that some sort of steel—e.g. Thomas steel—"could be got at less cost by making other things with which to buy it from abroad than by the direct method of making it at home". This was the first branch of the argument; the second, which also drew support from contemporary instances of reconstruction, was that the British industry was suffering largely from relative inefficiency, due to the more recent date at which most foreign plant had been erected, to the greater energy always to be found in a young and expanding industry, and to the lack of enterprise bred in England by her success in the past. Recovery would come through re-equipment and integration, steps which were being taken under the influence of foreign competition, which was thus having a tonic effect. "Foreign competition appears to be about sufficiently effective to stimulate our industrial life and to prevent that (more) serious decline, namely a decline in personal efficiency."[1]

This line of thought was persuasive. In its first branch it was the one taken by Hugh Bell, who now succeeded his father as the most respected authority in the industry.[2] Up to a point it was sound. Ore resources *were* failing in Cleveland and on the West Coast; many finishing industries *were* flourishing; highest-grade British steel *had* a good market; competitive power *could* be greatly increased if works were re-equipped and production more scientific.

But several vital factors were left out of account or undervalued.

[1] S. J. Chapman, *Econ. J.* 1904, p. 623.
[2] *Independent Review*, Oct. 1903, pp. 52–73.

The extent and value of the East Midland ores, for instance, were neglected.[1] These ores matched the Lorraine deposits, and were closer to good coking coal. If they were taken into account, it was possible to assemble materials for all grades of steel save the highest rather more cheaply in Britain than in Germany, and far more cheaply than in the States; though to translate the possibility into practice required a considerable migration of steelmaking, and if full advantage were to be taken of it a considerable migration of big steel-using industries was needed too.

Next, many of the obstacles to structural and technological change in Britain were overlooked. The resistance to elimination which firms in the industry derived from diversification of product and various forms of integration with consumers, which was a ruling influence in the industry, was never discussed. The straightforward point that old firms were often strong through accumulated financial resources was of course appreciated; it was, indeed, a helpful point: for such strength constituted a defence against spasmodic dumping.[2] But the more complex and sophisticated resistances, which were of special significance in Britain—where accidents in the location of ores and markets had encouraged the growth of many scattered plants, and where markets grew much more slowly than in the chief rival centres—were ostensibly not appreciated. In many contexts this may be inferred from the absence of any overt reference; but there is a little more direct evidence. Professor Pigou, for instance, in a passage dealing with industries in general, where the context shows that he had the steel industry among others in mind, argued that protection would not bring significant economies by allowing an increase in the average size of plants, for "it can hardly be doubted that with an aggregate output so great as ours the point has already been reached, after which the size of the whole ceases to be a significant factor determining that of the representative part. Protection would of course mean an

[1] Chapman argued that the Midland seats of the industry were bound to decline relatively to coastal centres: he saw no prospect of new Midland centres (*loc. cit.* p. 619). Marshall was equally unsuspicious of the rich new supplies of ore (e.g. *op. cit.* p. 408).

[2] Pigou, *op. cit.* p. 17.

increase in the number of factories, but scarcely in their average size". There was a tacit but invalid assumption here that the lateral expansion of plants, where it made for economy, was equally easy whatever the rate of total market expansion. Hugh Bell's more popular references to the topic, it may be remarked, which were misleading, were in accord with this conclusion.

Thirdly, the view that developments in the industry were "natural" in the simple sense that they might have been forecast with scarcely any special knowledge of the industry and without reference to fiscal policies was associated with an unduly low estimate of the force of foreign competition. This misconception has been illustrated with reference to persistent dumping, whose existence was denied, and although spasmodic dumping was acknowledged, it was minimised. "Enormously exaggerated", "a trivial incident",[1] were characteristic references—based often on most inadequate evidence.

Fourthly, although it was not commonly mentioned in the discussion, it is important that for the most part an erroneous assumption was made that English makers were not at any disadvantage by reason of the relatively high price of labour in comparison with Continental labour.

The last main line of thought to be distinguished was that the effects of a tariff would be worse than any disease it was supposed to cure. Nothing less than a high permanent tariff, it was held, could be effective and practicable, and it would bring in its train a host of disadvantages. Most of these were too general in character to be discussed here. Protection for one industry would mean protection for all; there would be foreign retaliation; Ministry and Parliament, "hitherto chaste", Mr Winston Churchill averred, "because unsolicited",[2] would be corrupted; industrial fluctuations would be amplified because the sources of supply were narrowed; and industries would flourish for which the natural circumstances of the country were wholly

[1] Chapman, *Econ. J.* 1904, p. 621; Pigou, *op. cit.* p. 73. Pigou, writing in 1906, based his judgment on a Board of Trade Memorandum referring to unemployment and prices in 1902. The evidence on the same topics for 1904 was less satisfactory for his view.

[2] *Monthly Review*, p. 30.

unsuited. There was, however, one anticipated consequence more particularly associated with the steel industry. Protection, it was held, would mean the establishment of Trusts or, "worse still, a Kartell system". To guard against the risk of foreign monopoly exploitation, by adopting a policy certain to establish home monopoly exploitation, was not necessarily to choose the lesser of two evils: it would raise prices, it might entrench inefficiency.

It is doubtful if the first step in this argument was logically sound. It was quite true that no administrative machinery could ascertain precisely which goods coming into the country were going to be dumped, and duties specifically on dumped goods were thus impracticable. But it was also held that low permanent duties, such as Chamberlain proposed, would prove ineffective: that if price discrimination amounted spasmodically to 30 per cent, then a duty of 10 per cent could have but a negligible influence.[1] The reasoning here was not cogent unless dumped goods were goods which, having been made, had to be sold at whatever price. But in the steel industry, to avoid leaving plant idle, goods were made to be dumped, if they could be dumped at prices above prime cost. Now a small rise of price, such as a low duty might bring, *might* conceivably sustain home competitors; and there was no reason to assume that in times of acute depression German or other makers would necessarily find it worth while to continue utilising their surplus productive power to dump in England if their realised price fell by, say, 10 per cent. Moreover—what was more important—it was quite certain that with even a low tariff the trade would be far less attractive for persistent dumping, unless British makers ceased to compete, and realised prices were thus unaffected. Politically a low duty would doubtless have proved unstable, but economically it could not be dubbed in advance necessarily ineffective.

There were more important gaps, however, in the discussions of the influence of protection on Kartell growth. In the first place, the likelihood that Kartells would advance in any case was ignored, which was perhaps an outcome of the failure to

[1] E.g. Chapman, *loc. cit.* p. 623 and Pigou, *op. cit.* p. 75.

observe the structural rigidities which were growing in the industry. The cogent questions to ask in the tariff controversy with regard to Kartells were: at what pace it was most desirable that they should advance, and whether it was better that they should cover some or all of the products of the industry. A tariff would hasten their coming and make them more widespread. In the second place, while the danger that a Kartell would breed inefficiency was real, the ways in which this would occur were probably misconceived. At the onset of higher prices, with greater security and greater powers of obtaining export trade, the inflow of capital into the industry would no doubt have been great; but this would have been directed largely to the existing centres of the industry, and mostly to the existing plants. General efficiency would have been greatly raised, but many of the difficulties of developing new centres would have been proportionately increased. Thus there was here a real and important risk of inefficiency of a rather obscure kind. It was not the only risk. For the raising of prices which induced investment in existing plants would also have encouraged vertical integration between steelmakers and steel users. Inasmuch as this kind of integration, resulting from monopoly, brought structural rigidity and complicated managerial problems, it would be an additional route whereby inefficiency would ultimately result from Kartells. But where steel users put up their own works, it might, as argued earlier, have hastened the opening up of new mineral resources, and where this happened its effect would have been advantageous. Whether the net result on this count would be a gain or loss could not be foretold. Probably no economist, however, visualised these complexities; and in face of German experience the simple assertion that Kartells spelt inefficiency had at any rate an appearance of perversity.[1]

Thus the best Free Trade opinion on the economic problems

[1] It is needless to say that the prospect of a tariff hastening international Kartellisation was not remarked. It would have meant that monopoly exploitation was less likely to prove injurious to home buyers as against foreign buyers of steel; but monopoly exploitation would still have remained.

of the steel industry reflected much erroneous and incomplete information, and involved some faulty logic. It remains to see how the elimination of these errors would have helped the establishment of a case for protection or some other form of State interference.

Price studies would certainly have made the fear that dumping might prove destructive—whether by design or not was immaterial—appear something more than the fancy of harassed and inefficient industrialists. And where the ostensibly threatened trades were threatened in their home markets, the real possibility that the dumpers might ultimately establish international Kartells created a kind of situation which might, economists allowed, in theory justify intervention. Where the threatened trades were export trades the problem was far more complex, but also less disturbing. There was no risk in this case that British resources would be attracted into industries dependent on the precarious cheapness of dumped raw materials. But there was a risk, in export as in home trade, that successful dumping might be succeeded by monopoly. If steel prices consequently rose, and if, as was likely, demand for steel in export markets proved for some time inelastic, then these markets would be less receptive for other products. This would hurt British export trade in general. But not badly; and monopoly would be unstable so long as the British industry held the home trade, as a revival of competitive exporting would not require the rebirth of an industry. The probable loss here was thus less than where dumping occurred in the home market; and the main considerations in determining policy were the cost of protecting an export trade on the one hand, and on the other the cost of the transition in Britain from the industrial activity which was "destroyed" to another which should absorb the released resources of labour, capital, etc. With regard to the first, the necessary condition of success at the outset was the maintenance of much higher prices at home than abroad: a circumstance by no means uncommon, but for all that not advantageous if permanent, and a possible handicap to other exporting industries. But if the increased power which

State aid gave to the British industry to combat the dumper with his own weapon proved (as it very well might have done) to be a step towards international price agreement, the cost of protection (whatever its form) might ultimately have turned out to be small. As for the costs of transition, there was an obvious loss if specially trained labour and specialised equipment—steel melters and steel furnaces, for example—remained unused; while the discovery of new activities involved outlays and progressed uncertainly, too slowly to absorb all available resources and avoid unemployment.[1] These costs were recognised by economists, but they were minimised. The discussion of them, however, was coloured by the supposition that though every transition involved losses there was always a net gain; that in fact such losses were a necessary "cost" of progress.[2] In the situation considered here there was no necessary gain at all, and a chance of loss, to set beside the transitional costs; and if there were a possibility that situations of this kind might occur frequently and indeed that several might coincide, then the accumulation of even small individual losses might have been thought serious enough to be worth avoiding. All the more so if the progress of discovery could not, as many economists appear then to have assumed it could, and some still do, be conveniently hastened at will. The frequency of the occurrence and coincidence of such transitions probably depended on the size of the home markets of protected competitors and the rate of profits in them; and the risk could scarcely be dismissed lightly in view of German and American growth.

But such broad and complex problems as these final ones lie outside the scope of this discussion; and the bearing of the foregoing considerations on the particular problems of the steel industry wears a comparatively simple face when the true

[1] It might be argued here that the concentration of resources by the dumping country on attacking *existing* trades would ease the task of finding alternative employment in Britain for the displaced resources.

[2] Thus Professor Pigou (*op. cit.* p. 66) argued that "we ought not to condemn international trade on account of the transitions involved in it unless we are at the same time prepared to condemn mechanical inventions". He went on to point out that such transitions were "rarely accomplished in a violent and ruinous manner".

wealth of the British ore supply is taken into account, along with the high natural protection which the industry had in home trade, and with its structural rigidities.

The ore supplies made it possible to produce all grades of steel at least as cheaply in Britain as on the Continent. In view of this the natural protection was high enough to have made the home market well-nigh invulnerable had the British industry utilised its resources efficiently. British makers derived an average protection of about 10*s.* a ton from the difference between their costs and German costs in delivery to the British home markets; they could also more often avoid merchants' commissions, and for various reasons they could obtain a premium when selling against Continental rivals. Inspection and the mutual adaptation of consumers' requirements and makers' convenience were easier, the closer buyer and seller were to each other: quotations and deliveries could be quicker; personal contacts were often helpful; and national and municipal feeling and prejudice played their part. These influences affected different products unequally, but their force could be carried throughout the industry by policies of price discrimination, based on the diversification of output which was a characteristic of virtually all firms in the industry. Integration and analogous forces would similarly have fostered discrimination to defeat the foreigner. Success in this would of course have made the attack of rival steelmakers in "neutral" export markets all the keener, but British strength in export trades would nevertheless have been materially greater in absolute terms. As a result the rate of growth of rival industries would have been checked; their home prices might have fallen, their returns from exports would certainly have lessened, and their resources for plant improvement and extension have shrunk. But the structural rigidities of the British industry stood in the way of a quick reorganisation and re-equipment (personal and material) which should make the best use of all available resources; and every delay made such organisation more difficult and more disturbing nationally and internationally because on the one hand it increased the dependence of British

consumers upon both foreign suppliers and high-cost home producers, and encouraged a location of consuming industries adapted to this dependence, and on the other it lessened the possible effect of reorganisation by allowing the export surplus of rivals to grow.

Hence the most persuasive economic argument for State interference at this date could have been formulated in this way. Nothing save State action of some kind could bring about a quick reorganisation, which was to be desired (*a*) because it would eliminate the risks of depending on foreign suppliers of a vital raw material, who would probably become monopolists, (*b*) because it would avoid a profitless transition from steelmaking to some other activity, which was likely to occur in some degree if dumping continued, (*c*) because it would avoid some costs which were inseparable from a slow movement to efficiency. The outlay required to achieve these objects would be slight, and would certainly be required for a short period only.

The most certain force of this argument lay in its third point. Monopoly exploitation of home consumers was unlikely ever to have been very prolonged, and perhaps could never have become acute. It was mainly threatened in one big group of products—those made of Thomas steel. The prices of such products would at the onset of monopoly have been limited to an important extent by prices of similar products made in the British open-hearth industry, while the presence of ores in Britain meant that monopoly could always be effectively challenged by a revival of Thomas steelmaking at home. Large consumers who had benefited from dumping were in fact likely to be financially well equipped to make this challenge. In the same way the costs of transition which seemed probable were from one aspect certainly light. Only converter steelmaking showed signs of disappearing, and that not solely because of competition; while the amount of contemporary investment showed that an expansion was expected in open-hearth steelmaking, and this view proved to be justified.[1] The amount of specialised labour which was to be displaced by foreign competition was thus small, and

[1] Below, p. 336.

the equipment which was to be made valueless by the same force had already been long at work. Indeed radical reorganisation and re-equipment might well have displaced more plant, if not more labour, than foreign competition. It is nevertheless arguable that dumping tended to reduce the absorption of *new* resources in the industry, and that by doing so it may have both lessened the total volume of resources employed—in *all* industry—and diverted some resources into uses in which they were less effectively employed than they would have been, in the long run, in steelmaking, Thus the "natural division of functions between nations" may have been "distorted".[1] But the extent to which this occurred is necessarily obscure.

By contrast the special costs involved in a slow process of reorganisation are quite easily identified. The most serious of these arose out of the disharmony between the westward trend of the finishing trades and the easterly concentration of ore supplies. The westward movement did not start on account of the availability of foreign raw materials, but it thrived on it. Needless to say, the farther the development of western finishing had progressed, the greater the cost and disturbance—social as well as financial—which any readjustment aimed at an economic use of home resources would involve; and the greater the use of Continental semi-products in Britain as a result of the western movement, the greater was the clash in export markets bound to be if British makers ultimately used home products. Here then were the most dramatic and formidable costs, which were inescapable if radical reorganisation were delayed. But there were others, though less obvious. The process of patching, which, it has been seen, characterised the industry, was one which tended to crystallise the existing structure, to make the dislodging of existing firms more difficult, and also in a sense more wasteful. Moreover, this process was one which did not encourage the growth of specialist firms experienced in erecting new-style plant, and every delay in radical change meant that if and when it was ultimately determined upon there would be more foreign experts to consult, more foreign licence fees

[1] The phrase is Barrett Whale's, in *International Trade*, p. 168.

and royalties to pay, more foreign machine-makers to employ. Collectively these costs of delayed adjustment would almost certainly have outweighed any gains derived from a period of low "dumping" prices; and had State aid for steelmaking been invoked as a means of avoiding such costs it would have been a substantial argument.

But not an argument for protection pure and simple. It could not be assumed that the kind of transition which State aid was intended to promote would in fact occur at once when mere duties were imposed: the reverse was more probable. For, as argued above, though rising prices were certainly likely to stimulate large consumers of steel to develop the new ore districts and thus obtain cheap raw material, an earlier effect of rising prices would have been to increase both the resources and the borrowing power of all existing steelmakers, and thus to induce and facilitate expenditure in existing districts, probably on all existing plants. There was thus a risk that a mere tariff would have concentrated in a short time much of the maldistribution of investment which it was the object of State aid here to avoid. It could indeed scarcely have been otherwise unless those who held the key positions in the industry showed a strong disposition towards radical change. Failing this, only a form of State action designed to secure a particular kind of reconstruction could have been supported by the argument here presented.

In a situation of this kind it is not possible to adopt the right policy for the wrong reason. However far the legislators of the time may have been willing to adventure in State control—it was not in fact very far—they could not be expected to know what kind of reconstruction was "right". So that the chief economic advantage which *might* have been derived from State action to protect steelmaking at this time was completely out of reach.

Hence it is from one aspect a work of supererogation to complete the "correction" of the best Free Trade analysis, and to ask how a more correct view of the prospects of Kartell growth in the industry should have influenced the economists' discussion

of Tariff Reform, since the answer is not relevant in considering what policy should have been adopted. But from another aspect, for the study of the contemporary discussion rather than the discovery of the proper solution to the contemporary problem, the question is significant. And the answer is simple. If Kartells were coming in any event, it was a very slight objection to protection that it might hasten them, even if it be conceded that Kartells were objectionable. The kind of competition which occurred in the industry in their absence was in truth at most a very dubious advantage. But since protection would have added to the power of Kartells to exploit consumers, the argument for their supervision and control was undoubtedly strengthened. The risk of Kartells was not an argument in favour of Free Trade, but it was an argument against unconditional protection.

For the sake of fullness, one other argument for protecting the steel industry needs to be mentioned, though like the last point it had no practical relevance. It was the argument that secure supplies of steel were vital in time of war. This argument was often wrongly dubbed non-economic, as if there were an antinomy between progress and security, and it did not fall within the limits of the economists' discussions. But it was a serious argument for preserving the steel industry, even though its decline, as the Free Traders maintained, was to be compensated for by the rise of other industries; it was indeed the only solid argument which the Reformers produced to meet this point. Its practical significance disappeared, however, if the unprotected steel industry was likely to grow rather than to shrink in those branches which were significant for defence purposes.

The reasons for the incompleteness of the economists' discussion of depressed industries during the tariff controversy, in particular of the steel industry, are no less interesting in retrospect than the fact that it was incomplete. Partly the economists' treatment was conditioned by the lack of discretion, of subtlety, of scientific acumen, displayed in the arguments on behalf of Tariff Reform. Professor Ashley complained that "the free trade economists limited themselves too much to the rôle of

critic";[1] he might have added that their task here was light, particularly since the best of the Reformers—notably Ashley himself—did not cope seriously with the analysis of depressed industries, but left it to the depressed industrialists. Within their chosen sphere the economists were successful. They opposed to the Tariff Reform analysis of the steel industry's distress a plausible hypothesis—not very seriously considered perhaps, and not the strongest which might have been constructed—which explained distress by non-tariff factors; and so long as the scale of the tariff factor was not examined they could show conclusively that their rivals' case was not proven. But the economists could achieve this dialectical success without coming to grips with the substance of the Tariff Reform case, which was badly expressed, let alone with the whole substance of the problem which both parties were ostensibly trying to solve; and this is largely what they did. And it is natural to ask why they were content to do it.

There were some aspects of the problem where they could not reasonably be expected to recognise the limits of their knowledge. This was particularly true of the raw-material position. It may be astonishing that in conditions of competition the majority of steelmakers did not appreciate the extent of the unused ores of the East Midlands, and that the deposits had not been comprehensively surveyed though they had been tapped for forty years; but it should not be held up against the economists that they failed to anticipate the steelmakers in this. But the limited scope and unequal penetration of the handling of topics which either were or should have been in the centre of the discussion—dumping, the growth of Kartells, relative wage levels—cannot be dismissed in this way.

The most likely explanation is that economists were convinced in advance to an extent which they did not realise that the Tariff Reform case—which was not just the old protectionist case in disguise—was wrong: hence arguments and facts seemed the more forceful and credible in proportion as they tended to demonstrate this conclusion. Even writers who admitted that

[1] *Econ. J.* March 1904, p. 9.

"our information on the whole subject was painfully imperfect" found no difficulty in throwing their weight. "When through the half lights of inadequate knowledge, warnings of grave disaster gleam, it behoves a statesman", Professor Pigou argued, "to decline adventure and dwell in the beaten paths."[1] The Tariff Reformer, sensitive to the gleam of other warnings, would have drawn the opposite moral, and unless his fears were illusory he might have been justified. And though the economists triumphed in argument, the inductive and analytical bases of their case seem scant warrant in retrospect for their complete assurance in implying not merely that the Reformers' case *had* not been proved but that it *could* not be proved, an assurance which is made none the less clear by an occasional disclaimer. In problems of this kind there is always room for doubt, but it seems reasonable to attribute this assurance to the influence of tradition. Political Economy and Free Trade had been associated from the start, and the subject had gained much of its prestige from this association. An economist was bred as a partisan in the tariff controversy, and the tone of professional utterances in the 'eighties and 'nineties was dogmatic and intolerant; any protectionist who was not seeking to protect his own selfish interest was regarded as a manifest idiot, "unable or unwilling to follow the threads of intricate argument". Strong traditions of this kind are hard to dislodge when they can be supported by good, if not infallible, reasoning, and when they also have, as Free Trade had, a strong emotional appeal as well. It felt good to be the observer of remote causes, to be immune from panic fears and win by waiting, to protect the common weal against "vested interests". And there was obviously little in the circumstances of Chamberlain's campaign to disturb and much to entrench the economists' traditional loyalties. His supporters with few exceptions could be easily fitted into the two recognised categories. Depression (which was to be expected after a war) was less acute than in the 'eighties and 'nineties, when it had been weathered without surrender to the protectionists. Moreover, as the immense importance attached by the

[1] *Op. cit.* p. 117.

economists to the dangers of political corruption suggests, the advocacy of Free Trade regained with the growing force of socialism all its symbolic rôle in the struggle against *étatism*.

The economists' subjection to tradition probably led them to the correct immediate judgment on the policy of the Tariff Reform party; its vicious effect is to be traced in their continuous tendency to neglect an important range of economic facts, a neglect which notably affected the subsequent impact of their work on policy. Expressed very broadly, it may be said that the field of work which economists chose reflected the belief that when there was competition unimpeded by State action at home the development of industry was likely to be more uniformly healthy than when there was some kind of State assistance. Thus problems of industrial dynamics could and should be left largely to look after themselves, and an economist's concern, in the task of combating poverty, was to discover what degree of interference in the distribution of the national income could be "tolerated" by the productive mechanism. Hence, when the conditions which had moved the early Tariff Reformers had become accentuated and aggravated to such a degree that State action was politically unavoidable (though some would hold still economically unwise), the problems involved had never been carefully analysed.

Though the steel industry was the chief subject of the industrial *malaise* which was the starting-point of the Tariff Reform movement, its problems were not those on which contemporary opinion in the controversy crystallised. For Chamberlain protection was an incident in Imperial policy; and it was the need of a new Corn Law to give life to Imperial Preference which divided opinion, divided the Cabinet, and determined the political issue. The story is familiar. "The Prime Minister accepted retaliation as a means of reducing tariffs, but he refused to swallow the taxation of food, and decided that no changes should be made before a General Election."[1] Some colleagues would not go so far. When the General Election came in 1906 trade was rapidly recovering; even the steel trade was

[1] G. P. Gooch, *Life of Lord Courtney*, p. 489.

establishing new records; and the election went badly for the new policy. "If Chamberlain were a man of forty instead of seventy, it was shrewdly observed by Lord Courtney, he might look forward to gain his day within twenty years, through the internal divisions of an opposing majority."[1] It was more than twenty years before his son succeeded; and during this long interval the problems which were implicit in the steel industry at its beginning became gradually explicit.

[1] *Ibid.* p. 508.

BOOK III

WAR AND PEACE

Chapter XIII

PRELUDE (1905–1914)

In the steel industry's history between 1904 and 1914 there was something to satisfy both the Free Trader and the Tariff Reformer. For the former it was a period in which the output and export of pig iron and of steel reached new high levels. There had been no catastrophe. For the latter it was a period in which Britain's imports of iron and steel doubled while those of rival exporters became almost negligible; in which the expansion of the British export trade, depending to a surprising extent on the import of foreign semi-products, was far surpassed by the expansion of the German and American trades; in which the British industry's hold on common-grade steelmaking was continuously and visibly weakened.

The rise in the total of British exports, above all in the total export of products other than pig iron,[1] compared favourably in these years with that in the most expansive periods of the 'seventies and 'eighties. Nor was it necessarily derogatory that, as the following table shows, while the international trade in steel grew by 8·5 million tons the British makers secured only 1·7 millions of this increment; no more than the Americans, and only one-half of the German gain. Some considerable fall in the relative importance of British trade was to be expected, for obvious reasons. But the British export of rolled products remained throughout this decade fairly constantly equal to nearly 72 per cent of the home consumption, after falling by about 5 per cent in the 'nineties, and this was well above the German percentage.[2] The average value per ton of the British exports was also above the German figure.[3]

[1] The export of pig iron reached its maximum in 1907, and this accounts for the peak total export of that year. The pig iron export of 1913 was 700,000 tons less than that of 1907.

[2] These figures are necessarily very rough, being based on conversions of foreign trade figures into ingot equivalents. There are no statistics of home production of rolled products, only of ingots. The German percentage was about 52.

[3] The British average was £11, the German £10·3.

Table XXIV

Exports of Iron and Steel (000 tons)

	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914*
U.K.	3263	3721	4682	5152	4097	4211	4588	4516	4808	4934	2376
Germany	2706	3297	3614	3478	3643	3984	4797	5298	5951	6401	3302
Belgium	716	1044	1048	1041	925	1057	1241	1260	1472	1479	763
U.S.	1168	1009	1326	1302	964	1240	1536	2188	2938	2907	863
France	487	562	459	681	654	579	536	498	656	751	347
Total	40	9633	11129	11654	10283	11071	12698	13760	15825	1647[illegible]	

* (6 months.)

Once the *composition* of the export trades is observed, however, more particularly in relation to the import trades of the chief exporters, the impression given by generalised export statistics is dispelled. The imports of iron and steel into Germany, France, Belgium and the United States amounted all told to just over 1,600,000 tons in 1913, and of this nearly 60 per cent was pig iron. But the import into Great Britain, after remaining fairly stationary till 1910, had mounted to 2·25 million tons, of which only 200,000 tons was pig iron, while over a million tons was composed of steel semi-products—billets, sheet bars, wire rods, and tube strip. As a pendant to this the British export of rolled products was dominated by the trade in sheets, mostly galvanised or tinplated. If the pig-iron trade, which had lost little of its importance, be left out of account, the growth of the sheet trades between 1904 and 1913 accounted for 40 per cent of the whole growth in the British export of iron and steel in these years. Of the remainder of the increment, over one-third was composed of other re-rolled products—hoops, tubes, wire, etc.—while the only heavy steel trades which expanded, those in structural steel and plates, accounted for no more than one-sixth, and this was partly offset by a decline in rail exports. The growth of British exports of rolled products was thus concentrated in trades which depended largely upon imports of foreign semis. But this did not reflect the general character of world-market expansion: there was ample scope for a growth of the export trades in common-grade heavy products, but in these trades the rival

exporting countries held the mastery. America's export of structural steel and plates was well over twice the British export in 1913; Germany's was four times as great. In the rail trade both these rivals had virtually caught up the British makers, and both had trades which with regard to diversity of product were far more broadly based than the British.[1]

Geographically, by contrast, the American trade was rather narrowly though not for that reason weakly based. Almost one-half of it was with Canada,[2] the rest mainly with South America and the Far East. The German trade was also superficially less broadly based geographically and more dependent on proximity than the British, since almost half of it was to Continental countries. But of these exports to Continental markets over a quarter were of pig iron,[3] some went to Dutch or Belgian merchants for re-export overseas,[4] while much went to markets, Spain and Portugal, for example, and Scandinavia, which British makers could reach as easily as the Germans, but in all of which they were outstripped.[5] Of the German export out-

[1] Exports of Iron and Steel by Commodities in 1913 (000 tons)

	U.K.	Germany	U.S.	Belgium
Pig iron, etc.	1124	856	287	17
Ingots, blooms, billets, sheet bars ...	4	701	230	159
Rails	507	501	453	165
Structural steel	122	557	367	96
Plates	136	461	295	196
Sheets	140	149	133	
Galvanised sheets	762	54	115	6
Tin plates	494		73	
Bars, sections, hoops, strip, etc. ...	438	1173	272	650*
Wire and wire rods	61	463	300	66
Wrought iron and steel tubes ...	165	307	282	6
Cast-iron pipes	235	73		

* May include sheet bars.

[2] In 1913, 1·4 out of 2·9 million tons.

[3] Over 800,000 tons.

[4] The quantity is not known.

[5] The German trade to Sweden, Norway, Denmark and Spain was considerably in excess of the British in 1913; for Portugal I have no complete data, but German exports of steel bars and wire alone to Portugal amounted to two-thirds of the total British export.

side the Continent over one-third (1·2 million tons) came to Britain itself, while the sales of products other than pig iron in non-British overseas markets exceeded the British sales. In these markets the Germans had obtained a marked superiority in the trades in heavy-rolled products, merchant steel and wire, the British export being dominated by coated sheets and cast-iron pipes, which together accounted for 40 per cent of it.[1] British makers now found the chief outlets for products, other than pig iron, in the Empire. Here alone, virtually, was there an expanding market for their heavy products—plates, girders, rails—which offset declines elsewhere; but the Empire was a good market too for the stronger trades in re-rolled products. In a slight degree the British maker was helped here by tariff preferences, though much more by commercial contacts, the absence of linguistic difficulties, and the influence of financiers and consultants. Even here, however, the penetrating power of German sellers was impressively shown in some markets and some products; in the trade with India, for example, in plates, girders, railway wheels and axles, and above all in merchant steel, and in trade with Australia in the same products and in wire.[2] All told, the German exports of steel products to Empire markets came to close on 400,000 tons; and it might fairly be said of the German trade as a whole that it was more broadly based than the British geographically on the eve of the war as

[1] These figures help to illustrate the position:

	Exports to Japan (000 tons)		Exports to Argentine (000 tons)	
	U.K.	Germany	U.K.	Germany
Plates	18·8	31·3	2·4	
Rails	0·1	25·8	54·6	64·6
Girders	2·7	14·0	7·8	35·5
Bars	23·5	98·7	12·9	89·1
Wire	0·7	30·5	5·5	42·2
Sheets (coated)	83·8		94·9	5·4
Tubes ...	6·1		10·3	13·6
Pipes (cast)	0·1		81·2	

[2] The German export of these products totalled 141,000 tons to India, 107,000 to Australia: the British figures were (roughly) 200,000 and 225,000 tons.

well as with regard to diversity of product[1]. The same might also be claimed for the Belgian export, which though it remained much below the British had continued, like the German, to grow faster than the British, and retained its great significance as a trade which derived no sensible aid in competition with Britain from geographical situation, Imperial bonds, financial contacts, tariff protection, or a large home market.

When the composition of the exports has been examined the fact that the German export viewed compositely was smaller in relation to German home consumption than the British is seen to be of very doubtful relevance; for it is clearly vital in judging export strength from this angle to regard the composite export as the product not of one but of several industries. Certainly in Britain the re-rolling industries were, save for the bar manufacture, mainly independent of the heavy steel industry. If this distinction be taken into account the German heavy steelmakers are seen to have exported a higher percentage of their products in 1913 than their British rivals. The British re-rolling industries on the other hand exported a higher percentage of their output than the re-rolling plants of Germany; but this was not an indication of the strength of the British heavy steelmaking, since half the raw material of the independent British re-rolling firms was imported.[2] If indirect exports of steel in the form of fabricated goods—engineering products, ships, etc.—were taken into account it is certain that the percentage of the product of

[1] The statistics published by the N.F.I.S.M., the League of Nations (*Memorandum on the Iron and Steel Industries*, 1927) and the Balfour Committee are all incomplete, and give a misleadingly narrow impression of its geographical scope at this date.

[2] The statistics are difficult: I have used the *Census of Production for* 1907 as my guide for the output of British products. For Germany there are production statistics as well as export statistics for 1913 (published by the N.F.I.S.M.). The British export of rails was a very high percentage of the total production—over 60 per cent. But taking rails, girders, sheet bars and plates together—products often made by the same firm—the Germans exported 26 per cent, the British 22 per cent, of their make. If the trade in bars be included the German percentage was unaltered, the British slightly fell. The British makers of coated sheets exported 80–90 per cent of their output, much above the German figure; British wiremakers exported 60 per cent against the German 50; British tube makers, at 40, equalled the German. But these re-rolled products in Germany were largely made by the heavy steelmakers, and were an indirect index of the competitive strength of heavy steelmaking.

British heavy steel works which was exported would more nearly match, if it did not surpass, the German figure.[1] It would, however, be misleading to emphasise this unduly, both because of the strength derived by British exporters in the fabricating trades through reputation, and financial and personal influence, and because the Germans were making notable strides in these export trades, the position from the British standpoint tending to deteriorate.

The impression given by a cursory glance at the trade statistics, that the German export of steel was a less imposing proportion of the total output of the industry than the British export of the British industry, is, then, misleading. It remains reasonable, of course, to regard the more rapid growth of the German home market, a feature which persisted up to 1914 as in the 'nineties, as favourable to the German trade, easing structural change. The population was much larger and grew faster, and its consumption per head went ahead of the British.[2] Yet though this was a favourable *environmental* factor, it cannot be regarded as a wholly autonomous influence, being in part a reflex of the policy and skill of the German steelmakers themselves, whose home prices, it has been seen, compared favourably with British prices in this decade despite the tariff.

The trends of international trade which have now been surveyed suggest that the structural situation of the first years of the new century may have persisted up to the eve of the war with little change, at least in the balance of the forces which were at work. And substantially that is just what occurred. No new forces came into play, no dramatic innovations, whether of method or of structure. The decade was one extremely favourable for steelmakers. World consumption of steel and the

[1] It is idle to try to guess the figures: the export weight of engineering products and ships are known, but they included cast iron and other metals as well as steel, and foreign as well as British steel, and products of the re-rolling as well as of the heavy steel trades. For the statistics of engineering see Balfour Report, *Survey of Metal Industries*, ch. II, *passim*.

[2] The League of Nations *Memorandum on the Iron and Steel Industries*, p. 33, gives the German consumption of iron and steel as 261 kg. per head in 1913, the British as 236 kg.

international trade in steel both doubled,[1] as a result of rising populations everywhere; of the quickening pace of invention, which hastened the advance of machine-making and the obsolescence of machines; of the search of the industrial countries for raw materials and food; and in a lesser degree of economic nationalism. It was but natural in an industry where reputation, contacts, and formal and informal integration counted for so much, that the British steelmakers should gain from this expansion of business. But so long as the cheapest British ores remained unused or used at the wrong places, British plant for heavy steelmaking remained relatively inefficient, the cost of British labour remained slightly above the Continental level, and the tariff situation was unchanged, the Continental export trades were virtually certain to grow at a faster rate; for the imperfections of competition could hinder but not prevent the advance of low-cost or low-price competitors, and were not potent in all trades.

The crucial feature in British structural development in these years was the absence both of radical change in the location of production and of a lessening of the subdivision of production. The number of steel-ingot producers did not fall, but rose slightly, between 1904 and 1914. No firms closed down, a few new ones were formed,[2] and there were only three important horizontal amalgamations, one of which, far from helping to eliminate plant or concentrate production, helped the development of a new plant.[3] Not only was the number of firms virtually stable, but their relative strength also; probably most firms expanded their output, and the increase in total output in the period was certainly not the result of the exceptional growth of a few plants. The Dorman Long group of plants, the biggest producing group in 1913, with an output in three plants of over

[1] Measured by production statistics consumption rose from 36 million tons in 1904 to 75 millions in 1913.

[2] E.g. Lysaght's, Pearson Knowles, and Skinningrove went in for steelmaking in these years; and the Bynea Steel Company was established in South Wales.

[3] Baldwin's virtually absorbed the Port Talbot Company in 1906, and by doing so strengthened it to compete with Guest Keen's. The most important amalgamation of the decade was the one which resulted in the Workington Iron and Steel Company in 1909.

700,000 tons of ingots, had expanded its output much faster than the average: so, possibly, had Colville's (who made 320,000 tons in 1914);[1] but these were not representative, and contributed only a small part of the total increase of ingot output. It is doubtful whether any other firm save Dorman's had an annual output above 500,000 tons, and it is unlikely that more than six firms all told had outputs exceeding—in most cases barely exceeding—300,000 tons. It follows from all this that there was no notable shift into the cheap ore districts, and the following table makes this amply clear:

Table XXV[2]

Steel Output by Districts (average annual in 000 tons)

	Scotland	S. Wales		Sheffield and Leeds		N.E. Coast		N.W.* Coast		Rest	
	O.H.	O.H.	Bess.	O.H.	Bess.	O.H.	Bess.	O.H.	Bess.	O.H.	Bess.
1881–5	212	138	433	41	308	23	293	21	421	23	—
1891–5	472	233	386	135	257	520	353	106	453	78	98
1901–5	1045	713	396	237	318	928	350	164	581	229	220
1906–10	1171	1009	379	379	322	1247	385	190†	445	360†	229
1912	1047	[illegible]	[illegible]	589	336	1599	314	255	312	430	232
1913	[illegible]	1807		879‡		2031				1118	

* These districts are not quite the same for the two processes. The Scots make of Bessemer—it may have been between 50,000 and 100,000 tons by 1913, and never much more than this—is included in the "Rest". For the open-hearth statistics the fifth column is entitled "Lancashire and Cumberland", and presumably includes the open-hearth plants near Manchester.

† The total of these two is correct, the subdivision a guess. For two years out of five only a joint figure was published.

‡ These figures are for "Sheffield" and the "West Coast" alone respectively.

[1] *I.C.T.R.* April 22, 1921, p. 570.

[2] These figures (to 1912) were collected by the B.I.T.A. and appeared in its *Annual Report*, until this ceased publication after 1906. They were then published in *I.C.T.R.* They were reproduced by the Board of Trade in an annual series of *Returns relating to Iron and Steel*, issued from 1910 to 1913. They have been overlooked by the Balfour Committee, whose *Survey of Metal Industries* states, p. 118, that "such statistics are only available from 1913". The 1913 figures published here come from the N.F.I.S.M.; they were published, with much less subdivision, by the Balfour Committee. In the original (N.F.I.S.M.) the "Rest" is subdivided: Lincolnshire, 241; Staffordshire, Shropshire, Worcestershire, Warwickshire, 465; Derbyshire, Leicestershire, Nottinghamshire, Northamptonshire, parts of Lancashire and Yorkshire, 412.

Growth was most, it will be seen (and of course it meant some cost reduction), in districts where basic steel was made; but expansion in the cheap ore districts was not worthy of isolation in any statistics published before the war and is included in the "Rest" column, which embraces among other firms the four Staffordshire steelmakers,[1] the L.N.W. works at Crewe, and the Glengarnock works: all substantial, if not very large, producers.[2]

While British development was marked by the persistence of subdivision and of locational anomalies, production in Germany was increasingly carried on in large plants, the minette regions grew increasingly important as steel centres, and in Westphalia the Rhine plants more and more dominated the scene. In 1911 a group of seven giant firms, comparable in scale to the leading American firms with the exception of the Steel Corporation, made close on half the total output of ingots; the seven leaders of 1905 had made about 40 per cent of the total. Three-quarters of the output of 1913 was made by fifteen firms with an ingot output of over 400,000 tons each, over four-fifths was made by firms making more than 300,000 tons.[3] And out of a total of 18·9 million tons at this date Lorraine contributed 2·3 million tons, the Saar 2·1 millions, and Luxemburg 1·3 millions. Westphalia remained far more important than these collectively, but not for the production of Thomas steel and the more common qualities. German structural changes were thus adapted to cost reduction and to the most advantageous use of available raw materials; whereas British changes precluded the best use of resources.

That the contrast of 1904 should be accentuated in this way was inevitable unless those few firms in key positions in Britain changed their policy. And, as shown earlier, they did not do so effectively in this period. The promise of the amalgamations of 1899–1904 proved illusory; there was a consolidation of steel-

[1] Hickman's, Patent Shaft, Round Oak, and Shelton.

[2] In post-war statistics (N.F.I.S.M.) the output in Lincolnshire for 1913 is given as 241,400 tons: there were two plants.

[3] The scale of the German firms is indicated by quota allocations in the Steelworks Union: the quotas for 1904 may be found in Jutzi, *op. cit.* p. 32; for 1911 in Leisse, *op. cit.* p. 56.

making firms at Workington in 1909, but an effort at further consolidation in South Wales failed in 1906 when Ebbw Vale refused to be enveloped in Guest Keen and Nettlefold's,[1] and there were no successful endeavours in any other of the chief centres. By 1913 there were signs that the re-rollers were being tempted into the East Midlands, but the actual volume of their developments was as yet small. Lysaght's, of Newport, had built a new iron and steel plant at Scunthorpe (the Normanby Park Works) which was just coming into production. A neighbouring blast-furnace plant, the Redbourn Hill Works at Frodingham, had been bought by a Welsh tinplate firm which was closely associated both with Richard Thomas and with the Lancashire bar makers, Monks and Hall;[2] but Redbourn remained as yet merely a smelting concern and may have been still thought of only as a source of cheap pig iron for Wales and Lancashire. There was yet a third change in prospect on this Lincolnshire ore field, one independent of the re-rollers; for, as noted above, the Steel Company of Scotland had decided to come into the district to make steel plates in association with the Frodingham Iron and Steel Company.[3] These developments suggested that in the next decade the British industry might adapt itself more radically to the changed circumstances in which it was working, but there were equally signs of the continuing strength of those forces which tended to warp locational adaptation. Apart from Lysaght's Normanby Park plant the only wholly new combined works of this period[4] was the Partington Iron Works erected by Pearson Knowles near

[1] *Iron Age*, Jan. 11, 1906, p. 180.

[2] *Company Records* (Redbourn Iron and Steel Company). Monks and Hall took the ordinary shares of this company in 1905, but sold them to the Cwmfelin Steel and Tinplate Company in 1908. The Chairman of this company was Frank Thomas; two other Thomases were also directors, along with F. W. Monks of Monks and Hall.

[3] Above, p. 275.

[4] The building of a steelworks adjacent to the Skinningrove blast furnaces did in fact also create a new combined works. For the finance of the firm, above, p. 273. It is said that Redpath Brown's was in from the start, and that the strategy of the scheme was in part to protect this firm of constructional engineers from the Steelmakers' Association. The *Company Records* do not show the firm in Skinningrove till 1917; but these records do not of course, reveal debenture holders.

Warrington in 1912. Like Lysaght's works it was small if compared with new German plants. Its location was determined by that of the re-rolling plants of Pearson Knowles and its associate firm, Ryland's, the wire-makers. There was local coal, but ore was to come, expensively, from the East Midlands.[1] Steelmaking once more was to come to the re-roller, whereas for effective international competition re-rolling should ultimately have moved towards low-cost steelmaking. A second equally impressive and remarkably prophetic incident illuminating the forces resisting locational shifts occurred at Ebbw Vale. The weakness of the Welsh hill plants was now growing increasingly plain. In 1911 production was suspended at the Ebbw Vale steel plant, and the owners were reluctant to restart. The workmen and the Newport Chamber of Commerce both asked the Board of Trade to make an inquiry, and on behalf of the firm the manager, Mr Frederick Mills, asserted that it was impossible, in spite of modernising, to secure sufficient orders—the foreigner always undercut him by 5*s*. a ton. The workmen urged that if sheets were made by the firm they would make a profit, and Mr Mills agreed. And though he thought that this could only be so for a short time, and foreign competition must ultimately cut into the profit on sheets, he advised his board to put down sheet mills and re-start their converters, which was done. Re-rolling in this instance was, as it were, to subsidise

[1] See the prospectus and early meetings of the Partington Company, *The Times*, May 6, 1913, etc. The financing was interesting. The company started in 1910 as a small private company owned by the directors of Pearson Knowles along with A. H. Cooper, former manager of the Clarence Steelworks and a son of the man who built up the North-Eastern Steelworks. This company started the construction of the works. It was turned into a public company in 1911, in order to raise further capital. It had already mortgaged its land and coke ovens for £106,496 to Simon Carves and Company, who made the coke ovens and supplied other plant. Pearson Knowles acted as promoters of the new public company: they guaranteed the interest on the preference shares issued, received 2 per cent for underwriting, and ½ per cent overriding commission, ½ per cent per annum on the capital as guarantors, and 5 per cent commission on the capital expenditure of the new company in return for services rendered in organising the erection of the works. The plant was set up to supply them with cheap billets—they consumed 1500 tons per week. A contract for ore was made with the Holwell Iron Company, Leicestershire. (*Company Records*: Partington Iron and Steel Company.)

semi-product making.[1] There was another manifestation of the same weakness of location at Dowlais. After the passing of legislation whereby Government contracts were to go only to firms who paid the rates of wages normally current in the trade concerned, it was alleged that Guest Keen's had obtained contracts for naval supplies and for the Indian railways but were not observing this provision. "The wages at Dowlais appear certainly to be low", Mr Harcourt agreed with Keir Hardie. At the Cardiff works of the firm, significantly, it was otherwise.[2] If further instances of the forces "fixing" locations and hindering the East Midlands were wanted they could easily be found —for example, in the establishing of small open-hearth steelworks by groups of tinplate makers,[3] and in the continued gravitation of re-rolling towards the West Coast.[4]

Meanwhile in Germany the way of adventurous concern-builders such as Thyssen, Spaeter and Stinnes remained open; and the rest of the industry was virtually forced to accept the pace set by the leaders, and was able to do so because of the diverse sources of capital which the industry could tap, in particular the rather competitive sources of the rich old industrial families on the one hand and of the banks on the other. Possibly this competition was, as many Germans both within and without the industry thought, unhealthy; too much capital was perhaps poured into the industry, the scale of production, the amount of new equipment and the rate of its obsolescence being as a result disproportionately high in relation to the

[1] *The Times*, May 23, 24 and 26, Aug. 14, 1911; *I.C.T.R.* Aug. 18, 1911, pp. 32 and 596. The workmen's representatives said that "should this (new) trade be affected so as to again cause a depression we as workers will give our practical support and sympathy in finding and trying to remedy the cause".

[2] *Ibid.* Aug. 18, 1911, pp. 270 and 756. Two years or so later a trade journalist noted that South Wales had done less well than the other steel districts in the boom of 1913, and, looking for a reason, he found it in the *high* wages of the district: *Ryland's Iron Trade Circular*, Jan. 10, 1914, p. 42.

[3] E.g. the Llanelly Steelworks was set up in 1907 partly by tinplate makers who agreed to take all their steel from it; and the Bynea Steelworks, built in 1913, was built also in part by tinplate makers on the same terms. A law case of 1921 revealed both these instances: *I.C.T.R.* March 5, 1920, p. 337.

[4] E.g. the Wolverhampton Sheet Company moved to Ellesmere Port in 1906; and the most important new bar works of the period was Whitehead's at Tredegar.

development of finishing industries, and the net return on investment relatively low through the necessity of forcing export sales. But whatever validity this criticism had, it referred to nothing new. The technique of structural change underwent little change in these years. Horizontal amalgamations of big steel producers helped rather more than hitherto in the emergence of the giants,[1] but neither Thyssen nor Krupp's, the chief representatives of the new and old respectively, owed anything to this. Horizontal association, on the other hand, played perhaps a slightly smaller part than in the earlier decade. The attack on the "pure" firms by Kartell policy had achieved such success by 1912 and the heavy steelmakers had obtained such a hold on the manufacture of the more refined products that competition among themselves in these trades became acute, and they were unable to agree (as they did from 1904 to 1912) upon quota allocations.[2] A conflict was also coming to a head between giant combined firms whose interests were mainly in coal production (such as Gelsenkirchen) and those whose interests were chiefly in iron and steel. The former preferred to keep the price of coal high and of steel low, a situation naturally unattractive to firms whose profits came mainly from steel, and whose coal resources were limited, inadequate for immediate needs perhaps and not sufficient to allow expansion. By 1914 firms predominantly steelmakers were threatening to leave the Coal Syndicate unless the whole of the steel industry, "A" and

[1] The union of Phoenix and Hörde has been referred to earlier: the resulting firm was the largest of the German producers. Amalgamation led to some specialisation of the component works. The second important fusion was that of the Deutsch-Luxemburgische firm (Stinnes), whose steelworks at Differdange dated from 1900, with the old Westphalian firm, the Dortmund Union. Here too the plants were to some extent specialised: the Luxemburg works, for example, made all the girders, becoming thereby the chief girder-making plant in Germany. Both these combines were vertical as well as horizontal, the Stinnes concern in particular being much linked with shipbuilding and engineering: Leisse, *op. cit.* pp. 122, 125 sqq.; Jeidels, *op. cit.* pp. 261–2; Tross, *op. cit.* pp. 44–5.

[2] Leisse, *op. cit.* p. 61, shows the growth in the importance of the more refined products—distinguished in the Kartell as "B" products. In 1904 they came to 42 per cent of the total quotas of the firms, in 1911 to 52 per cent. These products, unlike the "A" products (rails, semis, girders), were "quota-ed" only—not sold centrally at fixed prices. In 1912 even this limited control ceased: *Iron Age*, May 9, 1912, p. 1168.

"B" products alike, were effectively syndicated.[1] Hence not only was the scope of the Steelworks' Union narrowed a year or so before the war, but a more serious disruption of the Kartell system was threatened. But this was no more than a temporary check to the Kartell movement, as the firms tested their relative strengths and adjusted their relative importance.

By a rather fortuitous contrast price-control associations continued to make headway in Britain in this decade. But at the end they were still far less elaborate and effective than the Kartells, and were of minor importance in the international competitive struggle. Few of them were even national in scope. In heavy steelmaking, most important in this context, only rail-making was nationally organised. Scots, North-East Coast and Midland makers of plates and sections had district agreements, loose in form, not embracing all their products, and not always loyally observed.[2] These three groups had agreed by 1910 not to invade each other's immediate territory, and to parcel out some other British markets into, as it were, spheres of influence.[3] The latter part of this agreement was not, however, effective, and a more ambitious plan was devised in 1911 to combat both home (chiefly Welsh) and foreign competition by the introduction of a system of deferred rebates: consumers who bought controlled products exclusively from combine firms were to receive a rebate of 5*s.* a ton some months after the relevant transaction.[4] But this scheme failed and was dropped by the Scots after two years; the 5*s.* bait was not tempting enough, if only because of the low level of Continental prices, while the British outsiders were not intimidated into joining the combine. In particular the great Welsh firm, Guest

[1] A good discussion, drawn from the *Frankfürter Zeitung*, is found in *Iron Age*, June 18, 1914, p. 1547.

[2] A war-time law case revealed that immediately after agreeing to associate in price control in 1904 the managing director of the Clydebridge Steelworks undertook to give a Glasgow merchant (and other unnamed buyers) secret rebates off Association prices: *I.C.T.R.* Jan. 4, 1918, p. 32.

[3] Above, p. 278.

[4] Dorman Long's, among North-East Coast makers, appear to have kept out of the scheme: partly perhaps because they made no plates, partly because in the girder trade they were integrated forward. In general their policy was to secure markets by integration. All Scots firms save the Glasgow Iron and Steel Company seem to have joined. The Midland Associated firms were Frodingham, Round Oak, Patent Shaft, Shelton, Hickman's and Lilleshall. No North-West Coast firms were in.

Keen's, sold cheaply in all the West Coast markets and in Belfast. With its integrated and well-placed plant at Cardiff, it was no doubt able to produce more cheaply than the Scots makers. It would probably have associated, had it been left undisturbed in Belfast, Birkenhead and Barrow; but the Scottish associated firms were unable or unwilling to do this. Beardmore's insisted on selling to Vickers' at Barrow (with whom they were linked financially) and the Glasgow merchants would sell at Belfast. So Guest Keen's set out to extend its reputation and contacts by dumping before entering into an association.[1] Thus association prices never ruled in the whole of the home market, nor for the whole range of any firm's products. It is, moreover, unlikely that in the face of both home and foreign competition the prices fixed were ever high enough to give very good profits where most firms had high costs, and to help thereby in hastening radical change, whether directly by providing finance or indirectly by attracting it. Price control could not be a substitute for more radical change. Associated with central selling it could have brought economies which were not in fact realised, by securing a better distribution of orders. But until the progressive deterioration of the British cost position was checked it could not add very greatly to the value of local monopoly, though it would have been otherwise had British equipment been adapted to changed conditions.

Structural contrasts were doubtless the ruling factor in the cost situation. But there is little question that German technique was in advance of British where costs could be reduced without an increase in the scale of production. The Germans retained an unchallenged leadership as fuel technologists, and they challenged and possibly surpassed the Americans in the work of improving the mechanical equipment of the industry, particu-

[1] The Rebate Scheme was naturally very much discussed. E.g. *I.C.T.R.* Sept. 22, 1911, p. 441; Oct. 20, p. 663; Nov. 3, p. 729; Dec. 15, p. 896; and Jan. 2, 1914, pp. 12–13. The competition of Welsh plates is referred to in *Econ.* Oct. 28, 1911, p. 878. For Beardmore's attitude, cp. *I.C.T.R.* April 29, 1910, p. 673. Guest Keen's sold plates to Workman Clark for £5. 12*s*. 6*d*. delivered in 1914 (cp. record of a lawsuit arising out of the contract, *I.C.T.R.* Jan. 21, 1921). The average realised price for a group of six firms in this period was £6. 11*s*. 3*d*. net. Scots angle prices were free by 1914. Makers of both plates and angles now got "joint orders" by "coupled bargains."

larly in the rolling mills. Schwab emphasised this in his evidence at the Tariff Inquiry of 1908. "The Germans", he declared —he was following their lead in several ways—"have made the greatest advance in economic metallurgy of any makers in the last five years...they have developed their mechanical appliances to an extent that no other nation has, and have developed their quality to a greater extent."[1] An English expert, engaged during the war in copying German mill designs, enlarged on some aspects of this. "The greatest advance (in mill design) in the last fifteen years has been made by German makers: this... has not been any wide difference in design, but in the thought which has been given to every small detail, and in the high quality of workmanship....From many examinations of German mills one is struck by the high grade of workmanship as compared with English mills....The material used is wherever possible steel, and even nuts are made from a good steel and hardened."[2]

The Germans then were augmenting their cost advantage in these years by technical advances which were within the reach of the British industry without radical structural change. It is possible, on the other hand, that their advantage in labour cost was slightly narrowed. The statistics remain difficult. But it is likely that the price of British labour remained about 10 per cent above the Westphalian level and 20 per cent above the level in the Saar and Lorraine (the expanding areas) on the eve of the war.[3] In the boom period of 1912–13 no doubt the gap was wider, for the short-period wage movements in the

[1] *Iron Age*, Dec. 24, 1908, p. 1807g.

[2] *Trans. Birmingham Metallurgical Society*, VII (1918), p. 9. The subsequent discussion is illuminating.

[3] The Insurance Average for Westphalia jumped from £68 in 1904 to £89 in 1913, the final figure giving a weekly average of 35*s*., which was close to the Board of Trade's estimate of British wages in July 1914 (*Eisenerzeugende Industrie* (1931), p. 51, and Balfour Committee, *Survey of Industrial Relations*, p. 80). But the German wage was for a six-shift week, the British for 5½ shifts; while the Insurance figures tended now to give too high an average for comparisons, e.g. by including members of the salaried staff (*Eisenerzeugende Industrie*, pp. 8–9). The wage per shift in an important Saar works in 1913 was 5*s*. (Nutzinger, *op. cit.* p. 116. Hourly wages are given; the shift was regarded as a 10-hour shift: cp. graph, p. 106). No doubt this was representative. British wages were certainly above 6*s*. a shift.

two countries continued to be sharply contrasted, the British fluctuating greatly (on sliding-scale bases) with prices, the German little. The figures suggest that the cost of labour in the two countries may have been a little closer by 1914 than in 1904, and this would be likely if only because of the greater use of new equipment in Germany; but the advantage was still with the German maker.

German competition was the most immediately serious, but for the interpretation of the situation in Britain the advance of the Belgian and American trades was also significant. Was this also the projection of the forces operating at the opening of the new century, with no new element introduced?

In Belgium there was an advance in the importance of association. The chief impulse here was no doubt the desire of makers to partake in international agreements: the International Railmakers' Association, which would "quota" export markets in the rail trade, and agreements with French and German makers of girders and semi-products, which would eliminate or reduce foreign competition at home. The Comptoir des Aciéries Belges, formed in 1904, was a response to this international position. In the export trades most affected—in rails and girders—central selling was instituted, and in the girder trade a gap of about 12 francs a ton between home and export prices became normal. Other branches of trade were the subject of less rigid price control, and here the gap between home and export prices was less.[1] The advance of association must have added a little to Belgian export strength, since it helped the Belgian makers to take advantage of what tariff protection there was—ranging between 5 and 10 francs a ton on most steel products. Otherwise their competition received no new support in this decade. Their labour remained cheaper than the German, possibly cheaper than the French; their mechanical equipment was inferior to the German, possibly no better

[1] *Ryland's Directory*, 1910, gives a list of the shareholders in the Comptoir, and the address of the "Sales Bureau on Common Account". G. de Leneer, *op. cit.* pp. 118–19, indicates the limited scope of the central selling, and (pp. 111, 124–6) the influence of the Comptoir on prices, and its "rebate" scheme to compensate home consumers whose product was subsequently exported.

than the British; their fuel practice, on the other hand, was closer to the German than to the British; they made a success of Thomas steelmaking where British makers failed, and they more often enjoyed the benefits of technological integration. In these circumstances association was more important for them in their conflict with other minette users than with British makers; and their success may perhaps be regarded from this aspect as a token of the assistance which a low tariff might give to an industrial group in competition with rivals who had little or no cost advantage.

In the United States the bases of competition changed even less than in Belgium. The structure pattern of the industry remained comparatively static. There were still occasional consolidations, both vertical and horizontal; but unintegrated firms —"merchant" blast furnaces, open-hearth shops, and re-rollers —remained numerous,[1] while amalgamation was only a slight factor in increasing the scale of plants, and no important firms were eliminated. Firms, however, could and did expand rapidly owing to the vast growth of home consumption. The output of the Steel Corporation more than doubled in the period from 1901 to 1913. Some of its chief rivals grew even faster.[2] Indeed, it is significant that the Corporation declined appreciably in relative importance despite its rapid expansion; in 1911 it made only 54 per cent of America's ingots compared with 66 per cent in 1901,[3] and in the home market it lost more

[1] See e.g. list in *Ryland's Directory*, 1910.

[2] The growth of the chief rivals is shown in the following table (*Iron Age*, Oct. 22, 1914, p. 951):

	1901	1911, 1912 or 1913
Jones and Laughlin	485,753	1,490,122
Cambria	466,812	1,192,679
Republic	513,387	976,617
Youngstown	(begins 1902)	848,700
Bethlehem	18,146 (?)	703,792
Lackawanna	333,040	543,653
Pennsylvania and Maryland ...	515,091	539,414
Colorado	192,080	485,743
Inland	23,000	367,071
La Belle Ironworks	55,585	313,292

[3] *Board of Trade Returns relating to Iron and Steel* (1913), p. 43.

ground than these figures suggest, since it dominated the export trade.[1] None of its rivals had an export organisation, and though they contemplated a joint selling agency in 1912 they demurred, ostensibly through fear of the Sherman anti-trust laws.[2] Their growth was therefore concentrated at home. Apart from this shift in the relative importance of the big firms the most striking structural change of the decade was the progressive diminution of overt price control, accompanied by a real change of price policy. At the opening of the decade, it has been seen, the formal "pools" were dissolved, and their possibly incriminating records destroyed.[3] But makers still met openly to discuss trade problems—including costs in relation to prices—over the dinner table, and until midsummer 1911 violent price-cutting was successfully avoided. There ensued a short period of ostensibly competitive price-cutting,[4] followed by what was called by the *Iron Age* a continuance of the "era of good feeling", during which, though makers did not meet save under the auspices of Associations whose membership was not restricted to the commercial leaders of the industry, departures from generally quoted prices were rare; but the price level was much below the "level of the co-operative régime".[5]

Both stages in the decline of overt price control resulted from fear of the Sherman Laws; the second was in a measure an outcome of the Federal Government's decision to proceed against the Steel Corporation as a monopoly. Perhaps the

[1] *Iron Age*, Jan. 18, 1912, p. 210; the Steel Corporation had over 80 per cent of the export trade.

[2] *Ibid. loc. cit.* and June 4, 1914, p. 1413. The joint organisation would have not only handled the selling, and explored markets, but endeavoured "to mitigate untoward home circumstances". This meant bargaining for low freights in assembling materials and dispatching to the ports. Prices were admittedly to be below the home level.

[3] Above, p. 232.

[4] Price-cutting was inaugurated by the Republic Iron and Steel Company, recently reorganised and re-equipped. Possibly this was genuine price competition, representing a necessary technique in a price control system lacking quotas. A firm whose relative strength grew would lead in price reduction when orders were hard to obtain. Other firms would follow the lead, but not demoralise the market. The leader would gain by priority in reduction, not by permanent underselling.

[5] Above, p. 113, for the prices. For the history of price control, leaders in *Iron Age*, Feb. 1, 1912, p. 317; May 23, 1912, p. 1295; Feb. 19, 1914, p. 503.

lowering of prices was also calculated to dispel the impression of monopoly influence; it is interesting that the *Iron Age* thought retrospectively that prices during the "co-operative régime" had been unduly high.[1] But there may have been more behind the lowering of prices than this, something which linked it with the declining position of the Steel Corporation. High prices attracted newcomers and encouraged plant building;[2] encouraged, too, steelmaking by steel consumers;[3] and perhaps gave too much scope for the improving of plant out of profits to firms whose bond-interest burdens were light in comparison with the Corporation's. Hence lower prices, apparently spelling the end of monopoly exorbitance, may have been devised partly to check the extension of competition.

It is unlikely that the changes in these years affected the export situation save by increasing the disparity between productive capacity and the consuming power of the home market, and so increasing the desire for export trade. They did nothing to increase its remunerativeness; and the small volume of exports which went overseas bears out the view that the transport problems of the industry, both in assembling materials and in sending finished goods to the ports, together with the high price of many grades of labour, were insuperable obstacles to the building up of a large export trade save to a few markets. Works on the Great Lakes were of course amazingly well placed to sell in Canada; and some of the southern plants were tolerably well placed for Caribbean and South American markets. Even here the American trade probably was helped by the influence of American investors; and elsewhere trade was probably secured mainly in branches of trade—barbed-wire making, for example; tube making; structural steelwork—where American

[1] *Iron Age*, May 16, 1912, p. 1224. It was suggested that prices had been from 1·40 to 1·50 cents per lb., when 1·20 to 1·25 would have been reasonable.

[2] *Ibid.* May 30, 1912, renews discussions of this point, and controverts this view, though not conclusively.

[3] *Ibid.* Feb. 1, 1912, p. 317, shows that "pure" sheet makers were induced to go in for steelmaking owing to relatively high prices for semi-products. The linking of the Bethlehem Company with shipbuilding, and other links between engineering and steelmaking, may also have been in part due to the threat of monopoly steel prices.

conditions had enormously favoured technical advance. The advantages possessed here were not likely, however, to prove permanent.

As Lord Courtney had foretold, this decade brought no political success to the Tariff Reformers. If the elections of 1910 are at all a guide, however, Tariff Reform made more converts in these years than Free Trade. There are signs that even the more alert of Liberal statesmen were, perhaps under the influence of the Imperial Conference of 1908, becoming more sensitive to the Imperial aspect of Chamberlain's arguments; and the naval race with Germany undoubtedly cast a favourable light on a policy which promised at once to hurt Germany economically and to finance naval expansion without recourse to further direct taxation.[1] The extent to which opinion had been swayed remains, of course, unknown; and the immediate political prospects of Tariff Reform at the close of this period depended upon the reactions of Irish affairs on British opinion —a wholly irrelevant consideration—and upon the length and severity of the depression which was clearly setting in—a more relevant consideration, but liable to mislead. Had the Reformers succeeded, their policy with regard to steel would, it may be added, have inevitably been subject to the same criticisms as their proposals in 1904; both because the Reformers' party remained rather wilfully blind to the risks associated with the encouragement of monopoly, risks which the German and American experience of the decade had made exceptionally plain, and because the understanding of the industry's problems had advanced very little in the decade, whether among politicians, economists or steelmakers, and legislation based on a clear knowledge of the influence of dumping or of the location of the industry was still out of the question. How much so was soon to be revealed by the experiences of the war years.

[1] See e.g. D. Lloyd George, *War Memoirs*, I, p. 24.

Chapter XIV

HOW THE WAR AFFECTED BRITISH COMPETITIVE STRENGTH

The Great War changed abruptly the problems of the British makers. For five years it gave a respite from Continental competition, during which, after an initial period of uncertainty, demand was urgent whether on account of the war or (at its close) of reconstruction. The search for markets was replaced by a search for raw materials. Instead of association to keep prices up there was State control to keep prices down. The State intervened, too, to secure an unheard-of pooling of knowledge and resources, and to promote an unparalleled expansion of productive capacity. The industry and its customers were forced at long last to accept the basic process without irrational reservations, and the East Midland ore resources were systematically explored. State control was lifted in the spring of 1919; the urgent demand had dried up by the close of 1920, and by then Continental competition had reappeared. "The industry", according to the *Economist*, "had escaped from the hot-house atmosphere of war conditions to the colder but more invigorating breezes of free competition."[1] But the war conditions naturally left a permanent mark. It is the purpose of this chapter to examine how the competitive strength of the British industry was changed between 1914 and 1921. The corresponding changes in rival centres are examined in the second part of the chapter which follows.

1. THE SUPPLY OF MATERIALS AND LABOUR

The war forced the British steelmakers to make extensive, if not radical, structural and technical changes, and it is this aspect

[1] *Ann. Commer. Hist.* for 1920, *Econ.* Feb. 19, 1921, p. 380.

of the industry's history from 1914 to 1921 which was ultimately most important. But as a prelude to its study it is necessary to observe briefly the movements of raw material and labour prices in this period, whose disparities from the course of steel prices were significant both in the short run and more permanently. The nature of these disparities is indicated by the following figures.

TABLE XXVI[1]

	Price of steel plates	Wages per hour or piece	Prices of coal	Railway rates	Wholesale prices (*Economist*)
1913, average	51	65	49	100	46
1st Qr.	100	100	100	100	100
2nd	114	130	100	100	109
3rd	132	140	125	100	116
4th	136	155	125	100	130
1920, 1st Qr.	152	160	125	125	147
2nd	170	175	125	125	138
3rd	176	192	144	200	135
4th	176	200	144	200	104
1921, 1st Qr.	160	200	144	200	89
2nd	140	183	144	200	85
3rd	106	164	125	200	86
4th	82	130	100	200	77
1922, 1st Qr.	72	109	92	175	76

Changes occurred during the war period, but may be neglected, since the price-control mechanism was operated so that most steelmakers' costs were covered and a "reasonable" profit allowed. It was only after decontrol that relative movements affected steelmakers appreciably; hence the starting-point adopted above.[2]

[1] The first two columns are based chiefly on the sliding scale for steel smelters and rollers in a group of works in several districts. But see also below, p. 354, for wages. Coal prices are based on *Report of Accountants on estimates of Coal Prices made in* 1919, *P.P.* 1920, XIII, p. 213, the quarterly returns of costs and proceeds of coal published from 1920 onwards, and a *Memorandum* of the N.F.I.S.M. in *I.C.T.R.* May 17, 1921. The changes prior to 1919—wages had risen rather less than in proportion to prices, coal rather more, and transport not at all—are irrelevant to the argument of the following paragraphs, since price control had fully allowed for all this by the beginning of 1919 (see note 2). It must be emphasised that these figures for various reasons (e.g. they deal only with steel plate prices) are only a rough guide.

[2] F. H. Hatch, *The Iron and Steel Industry of the United Kingdom under War Conditions* (1919), pp. 35–7. Decontrol came in April. But prices had been raised on Feb. 1, so that no subsidies were needed to maintain the volume of output.

The disparities had a complex origin but are in essence simply explained.

The extent of all these price changes bore witness to the continuance of an inflationary policy up to the middle of 1920 and to the subsequent deflation. But the movement of steel prices was far more acute than that of wholesale prices in general, being subject to peculiar conditions of demand and supply. When the war closed there was a rush both to fill the gaps it had made in capital equipment—to replace merchant ships sunk by submarines, to replace railways and factories in the devastated areas of France and Belgium, to do repair work which had been delayed—and to re-equip war factories for peace-time purposes. These demands were most insatiable while the Belgian and Lorraine steelworks were being rebuilt and the German industry was suffering from its dismemberment. When Continental production began to revive it had become manifest that the new capital goods could not be fully and profitably employed; because, though the new equipment was often on a more than pre-war scale, the devastation of the war had checked the growth of purchasing power, while the pre-war pattern of economic activity, in accordance with which capital expenditure had been planned, was no longer appropriate in view of changed frontiers in Europe, new economic nationalism fostered by war and revolution, and the growth of new industries alike in countries which had been starved of normal imports from the belligerents, and in countries anxious to fill the gaps which the belligerents' withdrawal from overseas trade had left.[1] As the misjudgments of 1919–20 became manifest, the demand for capital goods, and so for steel, suffered an unprecedented contraction just as new productive capacity was everywhere being brought to completion. World steel production fell from 70 million tons in 1920 to 46 millions in 1921. The effect of this on prices in British currency was all the greater since inflation continued in Germany when British currency policy had been reversed.

The disparity between steel-price movements and the course

[1] This is all brilliantly dealt with by Loveday, *Britain and World Trade*, chs. 1–2.

of wages was largely a necessary outcome of the mode of wage adjustment, for where wages are governed by a sliding scale they necessarily reflect precisely the prices of past months. In the table this process is obscured during the rising price period, because at the outset there was a rise in wage rates apart from that depending on the operation of the scale; but in the falling price period it is unmistakable. If ore prices were traced their behaviour would show in the period concerned a similar time-lag: ores being bought on long contracts in 1919–20 in anticipation of brisk activity, their prices reflected the conditions of months previous to their delivery.[1]

The disparity between steel prices and those of coal and of railway transport was primarily due to Government policy. The mines and the railways were controlled till 1921. At the outset prices were kept low in both in the interests of reconstruction. Boom prices for export coal subsidised low home prices;[2] and in October 1919 an effort was made, unsuccessfully, and in view of the continued inflation unwisely, to bring railwaymen's wages down so that the Government could avoid losses here.[3] Convinced in 1920 of the need to cover costs in railways, it raised rates, most steeply in the summer just as a deflationary currency policy was adopted;[4] and there was no further change till an accumulated deficit had been paid off. By the close of 1920 export prices would no longer subsidise home coal prices, and for some months home prices were kept stationary, though not now low in relation to general prices, by a State subsidy. But the Government was convinced that here too costs must be covered by prices, and they chose to return the mines precipitately to private control in April 1921, putting on the owners the onus of making the adjustment. It needed a three-months strike and drastic wage cuts to scale prices down in the latter

[1] This point was emphasised in Messrs Wm. Jack's *Annual Review* for 1921.

[2] The price of exported coal averaged 33*s.* 4*d.* during Oct.–Dec. 1918, 63*s.* during Oct.–Dec. 1919. (*P.P.* 1920, XIII, p. 227.)

[3] The effort was defeated by a successful strike, with public opinion strongly for the strikers.

[4] No doubt the avoidance of a deficit on the railways was one of the steps which made deflation possible, by reducing the need for short-time advances.

part of 1921; and when they fell they fell less than steel prices, because of course the demand for coal was less dependent on the demand for capital goods, some needs accumulated during the strike, and there was little risk of foreign coal selling, like foreign steel, in the home markets.

The various elements of State policy with regard to currency and price control, each with a worthy object, could hardly have been better combined had it been intended to stimulate the recklessness of the boom and to aggravate subsequent financial dislocation and labour disturbances; and it is needless to emphasise the immediate evil of these disparities. But they had a long-range significance too; they were associated with changes of permanent importance in the competitive situation which tended to be masked during the boom.

Of these the most important was the rise in the price of labour which came early in 1919, which was incidental to the adoption of the eight-hour day almost throughout the industry, and was unmistakably permanent.[1] In all the belligerent countries the war brought a turbulent agitation for improved conditions, the reflex of pent-up resentments and irrational hopes, of release from the tension and responsibilities of war. In the steel industry they demanded shorter hours: a demand conceded in Germany in October 1918,[2] and shortly afterwards in France[3] and Belgium,[4] and later still, less universally, in the States.[5] In Britain it came with little turbulence, though the conciliation machinery groaned. The effect on costs is hard to judge. The lower-paid British workers received the same wages for the shortened as for the long shift; their wage per hour thus rose by 50 per cent. But the most highly paid men contributed one-third of the cost of the additional shift; their wage per hour

[1] I.e. at any given price and with any given technique the labour cost would be higher than it would have been before the war.

[2] *Eisenerzeugende Industrie*, pp. 160–2.

[3] M. Brelet, *La Crise de la Métallurgie* (1923), p. 91.

[4] Department of Overseas Trade, *Report on Economic Conditions in Belgium*, 1921, p. 91.

[5] An interesting record of the American labour conditions is given in *The Steel Strike of* 1919: a Report by the "Interchurch World Movement" (New York, 1920.)

or per ton was thus raised by 8½ per cent only.[1] The average increase may have been over 25 per cent; on the other hand the shorter hours led to increased productivity per hour in some stages of production,[2] so that, since many workers were time workers, the net increase in the price of labour was possibly not above 25 per cent and may have been less. How this compared with changes elsewhere is not known, nor, since the position has subsequently changed often, is it profitable to explore. But it may be remarked that if the proportionate increase in the price of labour were the same in all countries, the competitive disadvantage of the high-wage centres—Britain of course among them—would have been increased. The international character of the change made it inevitable in Britain, but not, as some writers suggest, innocuous.[3] The second change of permanent significance in these years was the quickened decline of Britain's "natural advantage" as a coal producer, due to the prodigal use of easily won coal during the war; so that coal prices could not return to the pre-war "normal" without some disturbance of wage standards.

So when British productive capacity was vastly expanded the industry's potential difficulties were multiplying. Yet with an odd irony its leaders, though initially forced into a policy of expansion, now lost, as will be seen, the caution and conservatism which had for long been ostensibly unwise and nationally harmful, just when business forecasting was more than usually a matter of guessing. How far were the changes they made calculated to offset the disadvantages under which they must work? This is the main topic of the next sections of this chapter, in which different aspects of the structural and technical changes of these years are successively observed.

[1] Balfour Committee, *Survey of Industrial Relations* (1926), p. 79.

[2] Balfour Committee, *Survey of Metal Industries*, p. 41. No careful study was made, and the data are not now available.

[3] E.g. G. C. Allen, *British Industries and their Organisation* (1933), p. 109, appears to do so.

2. LOCATION

In retrospect the crucial fact about the war-time extensions was that they maintained with little change the chief characteristics of the pre-war distribution of plant, both within and between districts, and therefore put new obstacles in the way of radical adaptation to changed circumstances of raw-material supply, technique, and competition.

In view of the setting in which the changes occurred and the manner in which they were brought about this was inevitable; and for the purpose of the war the policy adopted may have been right. The scope for radical change had not been recognised in the industry save by a minority. The controlling body set up by the Government[1] was chosen from leaders of the industry in the chief producing centres—the first three selected came from Scotland, South Wales and Sheffield[2]—and only by a miracle could this body have failed to represent the pre-war judgments of the majority of producers on such matters as the location and concentration of production. Hence when this group had to sanction, and very largely plan, a rapid expansion of capacity in the industry, there was nothing in the customary ideas of its members to lead them to advocate or even consider any far-reaching changes of structure; so much so that, in making their plans, they dealt first with extensions to steelworks (for it was steel supplies which first ran short), then with blast-furnace extensions, and finally they made a detailed survey of home ore resources.[3] Whether they would have felt justified in imposing with their "brief authority" changes which would have seriously damaged the prospects of existing firms or districts—including their own—may well be doubted; it would have seemed like hitting below the belt. But the problem to all appearances never arose. If it had arisen, however, it would have been linked to

[1] There is a semi-official history of this body, published privately: F. H. Hatch, *The Iron and Steel Industry of the United Kingdom under War Conditions* (1919).

[2] They were W. T. Maclellan, a Glasgow merchant, Colonel Charles Wright, a director of Baldwin's and the Port Talbot Company, and James Peech of Steel, Peech and Tozer.

[3] Hatch, *op. cit.* pp. 38, 20, 74, and *passim*. A cursory survey of ores had been made earlier.

another problem of more immediate practical importance. Was the far-reaching kind of change which would have met the needs of peace-time trading compatible with the urgent needs of war? In all probability only a policy of patching promised quick results. At many blast-furnace plants, for example, output might be fairly quickly increased by adding new auxiliary equipment—hot-blast stoves, blowing engines, hoists, railway track, etc.—which allowed more stacks to be kept in blast at once; or the addition of a new stack, in other instances, might keep existing auxiliary equipment more fully employed. And wherever there was excess rolling capacity, as there was in most works and in most districts (it was a natural outcome of diversification), there was a strong case for adding to steel-melting capacity. The outcome of such steps was to increase production with a minimum of new capital equipment, but without reducing prime costs as low as was possible; during the war this may have been the right policy, if only because the facilities for supplying new capital equipment in Britain were rather limited.[1] None of the more elaborate war-time building schemes was even approaching completion by the armistice. There was another technical objection to a radical departure from the customary structure of the industry—namely, that the more radical it was the more it would involve experiment, another source of long delay. Furthermore, one of the serious disadvantages of dispersed production in peace-time could be avoided during war; the Government could distribute orders so that rolling mills had good "programmes". The needs of war and of peace may thus very well have been in conflict. But of this the Iron and Steel Department of the Ministry of Munitions was only to a limited extent, if at all, aware.[2]

[1] This was a more compelling force than the mere desire to *economise* the use of facilities for creating new equipment so that, for example, more man-power might be available for direct war purposes.

[2] The semi-official history of the Department held that the extensions were only sanctioned if they were convertible to post-war needs, and said it was the object of the Ministry to provide "modern plants at pre-war costs" so that firms were "in a sound position to compete in the world's markets" (Hatch, *op. cit.* p. 39). There is no implication of conflicting needs here. Sir John Hunter, head of the Department from mid-1916, stated (*I.C.T.R.* Sept. 23, 1921, p. 456), with some exaggera-

The geographical distribution of the changes sanctioned by the Ministry is summed up broadly in Table XXVII, which is based on tables in the semi-official history. The most impressive feature of the steel plan, as revealed here, is the great concentration of building in Scotland and in the Midlands. For "Midlands" should be read mainly Sheffield and its environs, where the number of furnaces was increased by thirty-seven during and just after the war.[1] Numbers may clearly be a misleading guide, since furnace capacities vary greatly; but these numbers do not seriously mislead, as the new furnaces both in Scotland and Sheffield were mainly big, though not so large as three of those planned for Lincolnshire.[2] It is noteworthy that in Scotland no new blast furnaces were planned, and only one was planned for the Sheffield district—at the Park Gate works, Rotherham. There were, it is true, some improvements in the auxiliary equipment of the existing Scots furnaces which slightly added to their power of production; but this amounted to little. Thus the expansion of steel melting and smelting capacity was in no wise "balanced" in particular districts, and the new disparities emphasised earlier disparities, and did not remove them.

These broad figures are impressive, but for a full understanding more detail is required. Only this can show the full extent to which subdivision of production was aided, and it also brings out a development which must be regarded as positively retrograde, not merely an entrenchment of the *status quo*.

tion perhaps, that "no steelmakers expressed confidence in the utilisation of the extensions as commercial propositions after the war", but this was rather because they were not clear where the demand for greatly increased capacity was coming from, or because the extended plants were "unbalanced", or because good *new* plant had been added to poor *old* plant.

[1] The figures may be traced in the post-war *Statistics of the N.F.I.S.M.*, e.g. those for 1924.

[2] The trend is clearly reflected in production statistics; for despite new building the steel output of the North-East Coast never rose appreciably above the 1913 figures, and the Welsh output at most by 11 per cent, while the Scots output, remarkably high in 1913, rose 36 per cent above this level by 1918, and the Sheffield figure of 1920 was 22·5 per cent above that for 1913. In 1918 the Sheffield increase was almost certainly greater, but accurate figures are not to hand. For 1920 figures, cf. *Statistics of the N.F.I.S.M.*; for 1918, less subdivided, Hatch, *op. cit.* p. 19.

TABLE XXVII

Extensions arranged for in 1916–18[1]

District	New blast furnaces	New steel furnaces Basic	Acid
Scotland	—	31	8
North-East Coast ...	5	21	3
Lincolnshire	4	8	—
Midlands	5	38	10
South Wales	4	14	5
Cumberland and Lancashire	4	17	10

It is natural to suppose that the great expansions of steelmaking in Scotland and in Sheffield were a response to the peculiarly acute demand for the kinds of steel which these districts made well—shipbuilding steel in Scotland, high-grade armaments steel in Sheffield. Substantially this is, no doubt, what occurred. But in Scotland it had its justification in the pressure of shipbuilding, which probably made it necessary in the war. In Sheffield the justification lay in the traditional and, as it were, inborn skill of the workers. But it was already being shown by the close of 1915 that, for certain grades of armament steelwork, makers in other districts were quite competent—notably for the making of shell steel. The established producers pooled their information for the good of the industry as a whole. Moreover, there is no reason to doubt that skilled labour could have been made "mobile" in the circumstances of the war. There was then no need to augment the capacity of Sheffield for the manufacture of steel in very large tonnages of a standardised heavy product, which shell steelmaking amounted to during the war. But the new building programme included two important projects which must inevitably give new life to mass-production steelmaking in Sheffield, although for a generation it had been recognised by leading Sheffield makers that the location of the town was not suited to this, save to supply a predominantly local demand. Otherwise steel should be made

[1] Hatch, *op. cit.* p. 41, where the figures for each year are separated.

whose price was so high that transport cost was immaterial.[1] The two projects concerned were the building of a virtually new plant at Penistone by Cammell Laird's, and of a still greater wholly new plant near Rotherham by Steel, Peech and Tozer, with a meltingshop consisting of eleven sixty-ton furnaces.

If mass-production steelmaking had been for so long regarded as unsuited to the Sheffield district, it may be wondered why this reversal of trend occurred. The answer may probably be found in the rapid growth of the demand for billets and bars from the metal trades of Birmingham (a demand met before the war largely by imports), in a growing recognition of the cheapness of Lincolnshire and Northamptonshire pig iron as a raw material for basic steel, and in the rapid accumulation of capital by Sheffield makers during the war. Birmingham was remote from the relatively cheap steel of the North-East Coast, and South Wales, though as close as Sheffield, was necessarily burdened with fairly heavy ore costs, and, as has been seen, not blessed with ample scrap supplies. The retrograde trend around Sheffield was then in essence a misapplication of the resources upon whose proper utilisation the health of the British steel industry depended, a misapplication which was possible because steelmaking in the cheap ore districts had been hitherto so much retarded while expansion occurred elsewhere.

Apart from the Sheffield developments the war-time building left the character and most of the detail of location virtually unaffected. It was often emphasised that the war had led to the establishment of "new works...fed by home ores, and self-contained, providing on the same site modern coke-ovens equipped with by-product recovery plants, blast furnaces, steelworks and rolling mills".[2] The extent of this was in actual fact small. Only one wholly new combined works emerged—set up at Redcar by Dorman Long's for heavy plate making, hitherto outside their range. Their plant as a whole was now more than ever disjointed, though the new works had ample space (albeit divided by a railway line) and good access to shipping. There were one or two important instances in which pure works

[1] Above, p. 236.

[2] Hatch, *op. cit.* p. 42.

were turned into combined works—at Scunthorpe, for example, where a steelworks was added to a blast-furnace plant (without coke ovens), and at Port Talbot, where blast furnaces and coke ovens were added to a steelworks, which was itself also extended.[1] Both of these developments had been planned before the war. It was said of the second, and was possibly true of the first, that it had "unique facilities for the production of pig iron at the lowest possible cost".[2] The Port Talbot plant was admirably fitted to make pig iron from imported ores (but not *home* ores), being alongside the docks and equipped with mechanical unloading gear. Apart from these instances the war building did not increase appreciably the degree of technological integration in the industry, although all-round extensions at existing combined works sometimes maintained the existing balance; at the Normanby Park Works of Lysaght's, for example, and at Partington. But where disintegration was normal it remained —in Scotland, for example, and in Cheshire, where the steelworks and sheet bar mill of John Summers near Chester was duplicated. On the North-East Coast the design of the South Durham Company to build blast furnaces was actually frustrated, no doubt to the ultimate financial advantage of the firm. Most of the new coke ovens which were put up were in small groups by the mines, not linked to blast furnaces or steel works as technologists had for long advocated. As to the distribution of new equipment among different works, it is notable that several which were languishing were favoured as well as others which prospered. In Scotland, for example, important extensions were fostered at the Clydebridge, Glengarnock and Mossend works, none of which had flourished in the ten years before the war. In all these instances new open-hearth plants were put up, probably justified in part by an excess of rolling over melting capacity. The balance was more than redressed, and led to the building of new mills later. In South Wales, to take another example, not only was Port Talbot helped, and with it the move to the coast inaugurated by the Dowlais Company in 1892, but

[1] Annual Reports of Baldwin's meetings from 1915 onwards.
[2] *The Times*, May 13, 1915 (Report of Baldwin's meeting).

Ebbw Vale was enabled once again to renew its strength by putting up new blast furnaces and coke ovens and by increasing its steel-melting capacity. At Blaenavon, too, a new blast furnace was put up. On Tees-side there were extensions at all the steel firms: at Bolckow's changes were sanctioned little less extensive than those at Dorman's though they involved additions only within the existing site, and there were lesser additions at the Skinningrove, Cargo Fleet, and South Durham works. Substantially this exemplified the Ministry's policy in all districts; there was no effort to concentrate production, or to lessen competition; on the contrary the Ministry worked wholly within the existing firm-structure (see table, p. 363).

3. TECHNIQUE

While the building of the war and early post-war years thus did little to improve the distribution of iron and steelmaking it raised appreciably the general efficiency of British practice. The industry emerged with a considerable amount of new and as a consequence fairly up-to-date equipment. In some important ways, too, the general level and range of technical skill in the industry had been raised. Yet partly on account of the patchwork character of much of the new building, and partly through the insufficient supply, or the neglect, of adequate technical advice, and the lack of experience, many of the faults which had for long characterised the industry remained. Much of the really new plant was as good as most to be found elsewhere; but it could scarcely be claimed that leadership was regained, or that the best units at any stage of production—save perhaps in open-hearth steel melting—were to be found in Britain. Moreover, advance was very unevenly distributed between the various stages of production and between the different branches of the finishing industry; there were branches where the average equipment was astonishingly below the best.

The greatest advances in the British industry during the war occurred in open-hearth steel melting and in two branches of heavy steel rolling. Between 1913 and 1923 the average capacity

The distribution of steel production (in 000 tons)at the close of the war is shown broadly in the following table. The numbers of *plants* per district, and the total number of *firms* (*), are given in brackets.

	North-East Coast	Scotland	Staffordshire, Shropshire, Worcester-shire and Warwickshire	South Wales and Monmouth	Sheffield	Rest	Total
Bright cold drawn and rolled steel ...	0·6	—	27·3	—	39·0	22·3	89·2 *
Plates (boiler)	48·7 } (7)	138·6 (9)	1·6 (4)	5·5 (2)	7·0 (5)	24·5 (4)	225·9 (28)
Steel plates, ⅛ in. and over	539·3 }	614·5	50·5	158·6	61·8	4·1	1428·8
Rails, 50 lb. per yard and over ...	124·4 (7)	7·3 (3)	3·6 (2)	104·3 (3)	53·1 (3)	122·2 (5)	414·9 (21)
Rails under 50 lb. per yard	71·7 (8)	11·4 (5)	9·8 (5)	35·0 (4)	3·0 (3)	18·4 (15)	119·3 (37)
Rails grooved for trams	17·5 (3)	0·8 (1)	—	—	2·6 (1)	15·4 (2)	36·3 (6)
Sleepers and fish plates	13·2 (8)	1·7 (5)	0·4 (3)	20·5 (4)	1·6 (3)	18·0 (12)	55·4 (35)
Sections: angles, channels and tees ...	306·5 (12)	323·6 (10)	145·6 (15)	32·4 (2)	12·4 (9)	52·3 (15)	872·8 (58)
Rolled girders, joists and beams ...	197·4 (6)	65·0 (3)	44·6 (4)	—	1·1 (2)	81·8 (7)	389·9 (21)
Rounds, squares, flats and hexagons ...	80·7 (17)	152·9 (12)	267·7 (33)	61·5 (7)	155·6 (26)	148·5 (23)	866·9 (110)
Wire rods	26·4 (3)	—	6·4 (3)	53·5 (3)	60·4 (8)	114·3 (4)	261·0 (20)
Hoops and strips	9·6 (4)	54·0 (12)	95·1 (21)	14·4 (3)	6·9 (8)	72·8 (9)	252·8 (56)

The tonnages come from *Statistics of the N.F.I.S.M.*, 1924; similar details are also given for forgings, uncoated sheets and spring steel. No regional distribution of the manufacture of galvanised sheets is included. This kind of information was only made available until 1925. The bracketed figures are obtained from *Ryland's Directory*. These numbers are only a rough guide. It is to be remembered that many plants had two or more mills for the same product, and that many mills were used for rolling different products.

of open-hearth furnaces rose from 40 tons to 50 tons per heat;[1] and although British fuel practice here as elsewhere may have lagged, there were many works which in other respects were certainly comparable with the best German, and better than the best French or Belgian, shops. In rolling the most widespread improvement was the building of high-capacity cogging mills, which in manipulative equipment embodied improvements introduced in the States in 1902, and thereafter rapidly adopted and developed by German and other Continental producers, but hitherto not found in Britain.[2] Plate rolling was also vastly improved, and three-high and universal plate mills were at length successfully introduced. Of the former T. W. Hand, a prominent mill designer, "had heard nothing but praise from such firms as are now using them";[3] and as to the universal mill "it would appear that former objections in Great Britain... were based largely on prejudice".[4]

The most widespread weakness in the industry was the persistent relative neglect of fuel economy. Even Sir William Larke, who was Director of the National Federation of Iron and Steel Manufacturers (successor to the British Iron Trade Association) and thereby the official exponent of the industry's standpoint, agreed in evidence to the Balfour Committee that in this respect "England was undoubtedly behind the Continent".[5] As before the war, this failing permeated the industry at all stages. For example, all the new coke ovens built during the war recovered by-products,[6] but probably less than half were of the "regenerative" type which used gas to best advantage.[7]

[1] Detailed figures are given in the *Statistics of the N.F.I.S.M.* for 1924.

[2] There is a useful survey of the rolling position by T. W. Hand in *J.I.S. Inst.* 1925, I, 43 sqq. For the cogging mills, pp. 44–5. At least six firms introduced mills with a capacity of close on 750,000 tons per year.

[3] *Ibid.* p. 112. There were half a dozen; and they are now firmly established.

[4] *Ibid.* pp. 62–3. Dorman's introduced one at Redcar; Stewarts and Lloyds' followed rather later, at Motherwell.

[5] Balfour Committee, *Minutes of Evidence*, p. 361.

[6] In 1919, 80 per cent of British coke was made in by-product recovery ovens as compared with 58 per cent in 1913: Hatch, *op. cit.* p. 99.

[7] Of new ovens put up in the Midlands (where most new building occurred) 434 were "waste heat" ovens, 387 regenerative: G. E. Foxwell, in *I.C.T.R.* Dec. 18, 1931, p. 946.

And since coking coals varied much in character even in neighbouring pits, and within individual mines, the continued practice of making coke ovens adjuncts to individual mines meant that there was great variety in the quality of the product, which made it impossible in smelting to minimise coke consumption, or to ensure a regular quality of pig iron.[1] At most blast furnaces, to take the next stage of production, much gas was still allowed to escape, and the gas collected was used wastefully: it was burned with too much air in the hot-blast stoves and the boilers, and the vast majority of blowing engines had a low thermal efficiency—most were reciprocating steam engines, and when more modern types were adopted the turbine was installed rather than the gas engine.[2] At open-hearth furnaces it was often necessary to use "cold" pig iron, the mixture of gas and air in the "ports" (or burners) was imperfectly controlled, and the flue gases were allowed to escape, whereas they could be utilised in "waste heat boilers" to raise steam.[3] In rolling, the most conspicuous waste of fuel was due to the prevalence of steam engines instead of electric motors for driving the mills.[4]

Cumulatively these losses were serious. An extreme index of their importance may be discovered in the contrast between the average consumption of coal in making a ton of rails in Britain in 1925—which was 3·4 tons—and the "practicable ideal" set up by a small committee of the Iron and Steel Institute (its members were Sir Robert Hadfield, Professor Bone, and Alfred Hutchinson) in 1919, namely 1·75 tons of coal per ton of sections.[5] This gave a slightly exaggerated picture because the "ideal" involved the linking in one plant of all production stages from coke making to final rolling. It has been remarked earlier that in some circumstances the fuel economies derived from linking smelting with steel melting might be more than

[1] W. Colquhoun, in *Trans. Inst. Mining Eng.* 1918–19, p. 62.

[2] *J.I.S. Inst.* 1919, II, pp. 21, 37–8, and *passim.* Of twenty-one plants examined only three had "double bells", two had open tops, and only five used gas engines. Heat losses in boilers and stoves were high, through the admission of too much air, and half the plants did not know the extent of these losses.

[3] *Ibid.*

[4] *Ibid.*

[5] *J.I.S. Inst.* 1919, II, p. 21, and *R.C. on Coal Industry* (1925), Evidence of Sir William Larke, Qs. 1019 sqq.

offset by disadvantages,[1] and the same holds with regard to the linking of coke making and the later processes. Indeed, German development since the war has suggested that, in this respect, so long as coking plants are fed from many collieries and run so as to make a uniform coke, disintegration may be the better plan.[2] Confusion often arose in discussions of this point, since the ideal of using no coal in an iron and steel works save that charged in the coke ovens had stimulated the most impressive instances of fuel economy, and it was tempting to conclude that complete integration was a pre-requisite of radical improvement. But most fuel economies could in fact be realised without this complete integration, and those which could not might in some circumstances be too expensive. For this reason, then, the contrast noted above was slightly misleading, but only slightly. The fuel wastes in the British industry (and for that matter the degree of technically indefensible disintegration) were undeniably of great importance.

At most stages of production there were other significant sources of high cost in addition. Smelting remained from many aspects a weak spot in the industry. There were still, Sir William Larke told the Balfour Committee, "no really good discharging facilities for large cargoes of ore",[3] as there were in the States and Europe. It has already been seen that only a few new blast furnaces were built in these years; and of these several were of very moderate capacities: one making 1000 tons a week from Lincolnshire ore was treated as exceptional.[4] The policy of improving existing plants proved to be disappointing—"there seemed", according to Sir Francis Samuelson, "no half-way house between leaving moderately-well alone and complete scrapping".[5] Mechanical charging remained the exception; so did the blowing of furnaces individually with a regular volume

[1] Above, p. 264. [2] See, e.g., *Rev. de Mét.* 1930, p. 178.

[3] Balfour Committee, *Minutes of Evidence*, Q. 6405. This was partly the fault of dock authorities. [4] *I.C.T.R.* May 23, 1919.

[5] In his Presidential Address, *J.I.S. Inst.* 1922, I, p. 36: "If we increase our engine power, we have not enough stove power: we may add new stoves if we have room, which often we have not: we may raise the height of old ones, if they are strong enough—even then they are probably not strong enough for the new pressure. If we surmount the stove difficulty we find our mains and connexions

of air.[1] The average output of furnaces was only half the German and (which was more significant) four-fifths of the Luxemburg figures.[2]

In steel melting, by the side of the advance in open-hearth melting is to be recorded a continued sterility in Bessemer practice—no new shops were built, and the process fell into increasing disrepute.[3] Similarly in rolling, while cogging and plate making advanced there was a continued lack of specialised high-capacity semi-product mills and of modern mills for the production of rods and light sections. Messrs Steel, Peech and Tozer set up a continuous billet mill near Sheffield, but although its operating costs proved to be from 6*s.* to 10*s.* a ton below the costs of other mills,[4] their lead was not followed; perhaps partly because, since the mill was handicapped by its site, it was an imperfect advertisement. The same firm adopted the continuous principle for strip and bar rolling, following Whitehead but embracing a slightly different range of products; and Whitehead himself carried out just after the war a project planned for 1914,[5] the erection of a second semi-continuous mill on an extensive new site by the docks at Newport (Mon.), admirably placed for importing raw material and exporting its products. It was destined to be one of the few persistently successful plants in the British industry. But these were isolated changes; there was no

are not large enough to take the increased volume of air. If by partial scrapping we get over all these difficulties we are apt to find that our yard is not equal to the increase of traffic.... We can get a certain distance on the road to improvement, but not as far as we should like...."

[1] *Ibid. loc. cit.*

[2] The German average was helped by the fact that higher-grade ores were used than in Britain. But Luxemburg used on an average a lower-grade ore; so did the French and Belgian makers, and their average outputs were also well above the British. E.g. in 1923 the figures were:

Great Britain	36·500	Luxemburg	45·5000
Germany	75·000	France	43·000

[3] E.g. the Barrow works was encouraged to extend its open-hearth plant and to give up Bessemer.

[4] In 1925 it was said that British costs (in rolling billets or sheet bars from ingots) were normally 25*s.* to 30*s.* a ton; U.S. costs about 15*s.* (*J.I.S. Inst.* 1925, I, p. 104). In 1931 a confidential quasi-official inquiry within the British industry showed the prime costs in a continuous mill to be 6*s.* a ton below those of other mills which were sampled.

[5] Information in a leaflet issued by the firm.

gainsaying the general conclusion that "the small mill had been woefully neglected".[1] Post-rolling equipment, too, was neglected. Mechanical cooling banks were rarities, and of these some were too small;[2] while according to Whitehead there were "innumerable instances of new plants which lacked the provision of ample railway facilities and stocking facilities".[3] He might have legitimately remarked, too, how some of the most ambitious new schemes lacked room for convenient extension should it be wished ultimately to carry on processes subsequent to rolling and shearing. In the past it had often been urged that British makers paid too little regard to the "layout" of their works,[4] and as often retorted that this was an unavoidable penalty of pioneers; yet here an error in forecasting was repeated of a type which experience should have made impossible. Not that the handicaps suffered as a result of bad layouts were underrated. In 1921, for example, the Lanarkshire steelmakers based a case against increased assessments for local rates partly on the ground that their layouts were far from ideal. (*Solicitor-General.* Is there a single steelworks in Lanarkshire which is ideal in its layout? *Witness.* Certainly not in Lanarkshire. In Scotland? Not even in Scotland. But there are such works in England and America.) And some gave evidence of scale. Colville's said that at their Dalzell works an "awkward sequence of work, a good deal of handling and rehandling and loading and unloading and transport...which could be avoided in a new works" cost them (the details were given) £43,575 a year—several shillings a ton. Stewarts and Lloyds' said that for the same reason their labour costs at Clydesdale exceeded those of a "properly arranged works" by 25 per cent.[5]

[1] *J.I.S. Inst.* 1925, I, p. 110.

[2] It is very common knowledge, for example, that the cooling bank of one of the new North-East Coast plate mills was not large enough to handle the product of the mill if it was working to capacity.

[3] *J.I.S. Inst.* 1925, I, p. 95.

[4] As early as 1870, when the foreign correspondent of the new *J.I.S. Inst.* pointed it out. Quoted in 1895, I, p. 17.

[5] The case is reported in *I.C.T.R.* Sept. 23, 1921, and on subsequent dates. The specific references here are taken from p. 491, and from a slightly fuller report in the *Glasgow Herald*, the issue of Sept. 22. The tonnage at the Dalzell Works was

Apart from its effect on plant, the war also affected technique by inducing modifications in the customary practices of many works. Such changes are by their very nature elusive and hard to value. They arose out of the increased need for higher-grade steels and the falling supplies of high-grade raw materials. On the one hand a great many firms all over the country were called upon to make shell steel, a steel far more exacting to produce than the mild steel for commercial purposes which most of them were accustomed to make; they had at their disposal the experiences of the five or six pre-war makers of shell steel and of the French industry, together with the results of investigations by the Ministry, and they became familiar with making steel to fairly stringent specifications.[1] In Sheffield itself a similar stimulus on a higher plane was provided by the demand for steels for aeroplanes, tanks, and the like[2]. On the other hand it became vital to use more scrap in making steel[3] and to rely more upon home ores—from both angles it was essential to use the basic process more. One of the first works of the Ministry of Munitions was to expand the scope of this process, to eliminate prejudices and to explore scientifically its adaptation to the making of relatively high-grade steels.[4] How far all this led to new technical achievements is not easily judged, but it certainly raised appreciably the general level of skill and introduced greater technical elasticity. Moreover, it gave the industry a taste of collective research. The firmer establishing of the basic process undoubtedly tended to lower British costs. Apart from this, these changes of practice were concerned directly

given as 1500 tons a week, and on this basis the loss amounted to 12*s*. a ton. But it is probable there is a confusion here, and that the Dalzell Works had in fact a much larger output.

[1] Hatch, *op. cit.* pp. 7–12. [2] *Ibid.* pp. 115–18.

[3] *Ibid.* pp. 32–3. Steelmakers were encouraged to raise their charge of scrap from the pre-war level (between 10–15 per cent) to 50 per cent. The increased demand was at first satisfied by the use of steel turnings, available in great quantity from the manufacture of shells. But this was not enough. An intensive search for scrap lying dormant in the country was made, and military and naval authorities put into circulation as quickly as possible all scrap in dockyards or recovered from battlefields, etc.

[4] *Ibid.* pp. 43–8.

with problems rather of quality than of cost reduction, and for this reason their influence on the international competitive situation may have been slight. The scientist had secured a more honoured position, but not at the point where he could produce most effect.

4. AMALGAMATION AND ASSOCIATION

"Recently", Sir Jabez Johnson Fergusson told Bolckow's shareholders in 1917, "a great deal has been heard about the advantages of combination": and he disagreed with most of it.[1] He was covertly referring to the Reports of a Departmental Committee, appointed by the Board of Trade in July 1916 when most of the war-time plant planning had been completed, "to consider the position of the iron and steel trades after the war". This committee, whose members were all engaged in steelmaking as masters or trade unionists, issued a majority report[2] which advocated a vast expansion of steelmaking for national security, and a reorganisation, involving much co-operation in different forms, so that production should be concentrated in large efficient plants (making each 300,000 tons a year or more), foreign ore supplies should be obtained with certainty and cheaply, and export prices should not be subject to the effects of acute competition among British exporters. With the first object in view, combinations among existing firms should erect wholly new plants on modern lines and with plenty of room for growth. Thereafter there should be an "entire redesigning and rebuilding of the plants which were essentially obsolete". Foreign ores and foreign mines should be bought by a syndicate representing consumers and merchants, and export selling be "central", in the hands of trade associations. The Government was to help by imposing at least a temporary tariff, by lending money to or investing in the various combines proposed, and by

[1] *The Times*, Sept. 27, 1917.

[2] *Report of Departmental Committee of Board of Trade to consider the position of the iron and steel trades after the War*, 1918, XIII, pp. 429 sqq.; more especially pp. 437–9 and 442–6.

exerting pressure so that though price control remained voluntary it was not made ineffective by outsiders.

Johnson Fergusson was ostensibly opposed to all these proposals save those concerning ore supply. Horizontal amalgamation was distasteful to him. "Small concerns would not be able to live in the competition of the future, but you couldn't describe Bolckow Vaughan's as a small concern." He would "require very conclusive evidence" before he recommended policies akin to those which had been followed in Germany or the States. In practice he appears to have found "conclusive evidence" in favour of vertical integration with consumers,[1] but this was not in the committee's plan. Johnson Fergusson was not an isolated opponent. Sir Hugh Bell, for example, himself a member of the committee, demurred from many of its proposals; he gravely doubted the wisdom of expanding steel capacity up to 15 million tons a year, and he opposed most forms of State intervention. Influential opposition of these kinds was perhaps sufficient to make the report a dead letter, and the changes which occurred in the firm-structure of the industry were predominantly of types not recommended in it. Horizontal amalgamations were few; instead vertical integration, which was in a sense its antithesis, was ubiquitous; and association between firms advanced only a little.

The formation of the United Steel Company was by far the most noteworthy horizontal amalgamation of the period. The first step here was the fusion early in 1916 of Samuel Fox and Company and Steel, Peech and Tozer, two Sheffield firms who competed at many points, and whose union allowed some concentration of production. In the summer of 1917 this Sheffield group, which had embarked on a great expansion of plants, set out to unite with two other important firms, one in Cumberland, the Workington Iron and Steel Company, the other a Lincolnshire firm, the Frodingham Iron and Steel Company, which had planned before the war in conjunction with the Steel Company of Scotland to build a big steelworks and plate mill on an adjoining site. The United Steel Company

[1] Below, p. 374.

as finally constituted embraced in addition another old Sheffield high-grade steelmaking firm—Doncaster's[1]—and a colliery company. The strategy of these fusions is not in all points clear. For Frodingham the step may have seemed to promise capital for the plate mill scheme; on the other hand it involved the withdrawal of the Scots firm whose experience and contacts might have proved invaluable,[2] and it was certainly not the kind of union which the Departmental Committee advocated. For Workington there was a chance of gaining from Steel, Peech and Tozer continued hold on part of the rail trade. Possibly all the interests concerned thought the new company offered an ingenious way of spreading risks—it had a foot in many trades and many districts. But from the standpoint of the Sheffield promoters, and particularly of Harry Steel (who was the real driving force), it is likely that the chief attraction of the links with outside districts were these: first, that they ensured a supply of pig iron and ores, hematite from the West Coast, where sources were falling into dangerously few hands, basic from Lincolnshire, whose product was amazingly cheap; secondly, that, as a contemporary journalist noted, a very severe competitor was eliminated.[3] The immediate competition between Lincolnshire and Sheffield was possibly slight, but the potential danger was obviously great. The Frodingham Company was the only Scunthorpe firm not wedded to a consumer, and might easily be tempted into the billet and bar trade which Steel, Peech and Tozer had just taken up in a large way. The union was thus protection for the new and unfortunate departure in Sheffield steelmaking which has been described above. It did nothing commensurate with its size to reduce the subdivision of production, which was the most promising object of horizontal amalgamation. The same may be said of another fusion, whose importance is perhaps more obvious in retrospect than at the time: the absorption of

[1] I understand that Doncaster's recently has withdrawn from United Steel.

[2] Above, p. 338. The Steel Company of Scotland felt bound to relinquish its half share in the Appleby Works when Frodingham entered into United Steel: *The Times*, Oct. 24, 1918. But it may have been reluctant to push ahead with the pre-war plan.

[3] *Engineer*, Dec. 21, 1917, p. 549.

the Clydebridge and the Glengarnock Steel Companies by Colville's. For several years before the war the former of these was periodically paid by the associated steelmakers to refrain from producing,[1] while the second had come to a stand in 1914; so the fusion here held out little promise of new concentration of production on the Clyde. Elsewhere there were no unions even of the importance of this one, though there was an effort, which proved fruitless, to unite Guest Keen's and Baldwin's in 1920.[2]

The crop of vertical integrations which above all else characterised the firm-history of these years reflected in the main the new uncertainties of the war and post-war period, and was scarcely at all technological in inspiration. The check to ore importing during the war tempted some users of hematite to absorb West Coast smelting plants and ore mines, and encouraged other firms—from South Wales, the North-East Coast, Lancashire, and South Yorkshire—to buy up mines and quarries in the East Midlands, so that their ore supply should be secure. After the war, in the short period of reconstruction demand, some new foreign ore interests were acquired, perhaps for the reason specified by Bolckow's chairman; and in the same period several steel firms bought blast furnaces because steelmaking capacity had been increased during the war much more than smelting capacity, and the unintegrated firms were afraid both of short supplies and famine prices. In the same way a number of firms bought collieries when coal supplies were erratic. Integration between steelmakers and consumers had a twofold origin. In the shipbuilding boom of 1919–20 many Clyde and Belfast shipyards bought steelworks to ensure supplies and to avoid monopoly exploitation, which looked like being prolonged even beyond the period of scarcity through the weakening of the merchants. At the same time there were steel firms who were equally anxious to secure outlets, often for productive capacity expanded during the war. Among these the armament specialists were the most prominent; whether by

[1] *I.C.T.R.* Jan. 1, 1909, p. 10, refers to the "closing of one important steelworks under subsidy", though no name is given. Cp. also *Glasgow Herald*, Sept. 20, 1921.

[2] *The Times*, Feb. 19, 28 and June 19, 1920.

purchasing concerns or, more precariously, by "starting on their own", they all went into some of the highly developed finishing trades—making heavy electrical equipment, motor cars and tractors, locomotives, or sewing-machines, railway carriages and wagons, diesel engines, rolling mills, and the like. But common-grade steelmakers responded, if more rarely, to the same stimulus; Baldwin's, for example, acquired a tube-making concern, and Bolckow's, having absorbed a sheet works in 1916, acquired control of Darlington Rolling Mills in 1920, and of the constructional engineering firm of Redpath Brown in 1923.[1] Thus the stimuli to integration, if more acute than long-lived, were manifold; and of course every response to them made them more compelling. One other influence, less direct than those hitherto discussed, intensified the process of integration. Most firms had war profits, which they wished to invest in bricks and mortar if only to preserve them from the shrivelling effect of inflation. As a form of investment vertical links had a dual advantage, since not only did one investment help another, but a firm never appeared to have all its eggs in one basket.

Among the innumerable fusions which followed pre-war models there was one which was new in type and of peculiar significance, namely the purchase by Baldwin's in 1919 of a steelworks put up by the Canadian Government for the supply of munitions.[2] Baldwin's object was ostensibly to make steel and tinplate in Canada, and so by working within the Canadian tariff and near the market to secure themselves against the effects both of Canadian nationalism and of American competition. Lysaght's had anticipated them in this kind of policy, though it had not pursued it by purchasing an existing works. In 1918 it had undertaken to build a sheet-rolling plant in Australia adjacent to the steelmaking plant of the Broken Hill Company.[3] Ryland's, the wire makers, and Stewarts and Lloyds', the tube makers, were to follow this lead to Broken Hill; and Stewarts and Lloyds' also set up a plant in South Africa.[4]

[1] *Ibid.* Dec. 27, 1916 and *I.C.T.R.* Feb. 23, 1923, p. 298.
[2] *The Times*, May 31, 1919.
[3] *Ibid.* Jan. 18, 1918.
[4] So did Dorman Long's.

Just as the ambitious projects for plant construction and reconstruction proposed by the Departmental Committee in 1917 were almost fruitless, so were their suggestions of collective action in buying ores and in export selling. But the scope of association was nevertheless widened a little by the war. The contacts between firms were far more intimate during the war than ever before, and though after its close individualism remained, so to say, rampant, more of the possible services of joint action were commonly observed. They were, indeed, in the chaotic post-war world, more obvious than before 1914.

In 1918 a new central association was formed, the National Federation of Iron and Steel Manufacturers, which in the ambiguous phrase of Sir William Larke "provided the forum in which the problems of the industry were discussed from a national standpoint".[1] Among those who established it many probably visualised it as the agency through which collective ore buying and collective selling were to be introduced, and at an early date it established committees to deal with these topics; but they were found intractable.[2] The ore problem did not prove to be urgent; and there was no experience on which selling quotas could be based, for the competitive power of firms was not revealed during the war and was constantly shifting as new plant went up. Makers accepted the principle of collective selling, and indeed appeared anxious even for international agreements—an extension of the principle of the Rail Pool to other products. Possibly they felt instinctively that it was good to make agreements when they were ostensibly strong. So in 1919 and 1921 negotiations were entered into with Continental groups;[3] but just as within the British industry quotas could not

[1] Cp. Evidence of Sir W. Larke to the Balfour Committee, *Minutes of Evidence*, p. 361. [2] *Ibid. loc. cit.*

[3] Very little was published on all this. The first negotiations were quasi-official, the second occurred on the occasion of a visit of the Iron and Steel Institute to France. There was also, in 1919, a movement for an international agreement including the United States. English makers visited American representatives. Opposition was strong: it was recalled that there had been tentative negotiations in 1911—just before the price-cutting inaugurated by the Republic Iron and Steel Company (above, p. 347)—and the Americans had wanted export trades to be proportionate to total production: *The Times, Trade Supplement*, March 1919, p. 290.

be agreed upon, so internationally. Many firms preferred to compete individually rather than accept the volume of trade which would come to them by International Kartell. They may have been right; so long as detailed information is lacking it is impossible to guess.

While the discussions of these projects proceeded the new Federation performed the functions which before the war had belonged to the British Iron Trade Association—collecting statistics, formulating and advocating the industry's standpoint on proposed legislation, negotiating concerning railway rates, and so on; and it scarcely got beyond this in the period under discussion. But the Association was moribund in 1914, and the new Federation was far more effectively organised than the Association had been at its best. Possibly the old body had suffered from insuperable internal dissensions, since it included both merchants and makers; the new body represented makers alone. The Association had never had a full-time secretary;[1] the Federation had almost from the start a full-time director and a full-time Statistical Officer,[2] both from the civil service, at the head of its staff. Within a short time it had a special department, with its own secretary, to deal solely with transport problems, and in the early 'twenties it set up a special department, staffed by technical experts, to deal with fuel problems. But this anticipates. It was symptomatic that while the statistics of the Association had been erratic and of uncertain value those of the new organisation were always admirable and uniform within their rather limited scope; the industry acquired the reputation of being one of the few British industries at all reasonably well equipped in this respect.

The practice of price control in the industry remained after the war in its central features very much as before. State control

[1] J. S. Jeans was secretary both of the B.I.T.A. and the I.S. Inst.

[2] At the start Sir Walter Layton, the well-known economist, and Mr M. S. Birkett. Sir William Larke became director in 1922. Before the war he was a member of the Sales Department of the British Westinghouse Electric Company. Sir William Peat was secretary until 1925, when Mr Birkett succeeded him. (There is a note by Mr Birkett in the Diamond Jubilee Issue of *I.C.T.R.* (1927), p. 179.)

had introduced one important change of principle: prices were fixed so as to remunerate (and remunerate well) most producers, but very high-cost producers (or production) were subsidised.[1] When State control was lifted, prices, where they were fixed, were equally adjusted to remunerate the high-cost firms—there were occasional exceptions[2]—and there was no question of subsidy. Control remained, as before the war, in the hands of numerous—one might say innumerable—associations, some of them regional, all dealing with a narrow range of products and without any co-ordination. Outside the rail trade control was never wholly effective save in the post-war boom, when it was unnecessary.[3] The effectiveness of control varied, moreover, from trade to trade, and in the absence of central selling there was ample scope for the "coupled bargain" and other well-established devices for the evasion of agreements.

But there were two changes which were significant, if they had little immediate effect and attracted little notice. First, all regional associations of heavy steelmakers now co-operated, virtually constituting a national association, and a uniform "delivered" price was established for the whole of the United Kingdom for plates and sections. The supersession of regionalism here was in a sense a result of the war, though it is probable that the conflict between South Wales and the Rest, which was occurring in the plate trade before the war,[4] would in any event have proved impermanent. But the interesting point was the selection of a uniform delivered price as the basis of price fixing. It was the sort of ideal aimed at before the war, but not attained.

[1] Hatch, *op. cit.* p. 36.

[2] E.g. John Spencer's, the firm who supplied the plates for the *Mauretania*, were prosecuted as "profiteers" in 1920 for charging more than the Steel Association price. Their reply was that this price was a minimum, fixed by a body dominated by basic steel makers. Their plates were of acid steel, and more expensive to make as a result. The firm soon closed. The Scots makers circularised their customers at this date that they were unable to sell at the Association minimum price: *I.C.T.R.* Nov. 14, 1919, p. 654.

[3] Even in the rail trade there may have been a short spell of competition, when the Port Talbot Works began to make rails. A letter in the *I.C.T.R.* (Dec. 30, 1921, p. 967) from the merchant firm of Skelton announced that this firm had the sole agency for export orders, and sought custom.

[4] Above, p. 343.

In 1923 a slight modification was introduced. Control lapsed wholly between July 1922 and November 1923. When it was revived, Great Britain and Northern Ireland were divided for the purpose of price-fixing into seven regions, for each of which a "delivered" price was established, which might, though it did not necessarily, differ from prices in other regions. Customers might be supplied from *any* region; but with whatever firm they placed their order they were to pay the same price. In Germany and the States a different principle had been adopted. Normally the price quoted was the price at one or more important producing centres, known in America as "basing points". Consumers paid this price plus transport cost from the "basing point"; if there were several basing points they paid the cost from the one within cheapest reach. The precise location of manufacture and the actual route of transport had no effect on the price; to this extent the system was like the British. But the differences were far more important than this similarity, since the systems were likely to encourage different trends in the location of consuming industries. The British system encouraged the dispersion of consumption; it was no advantage to the user of steel to be close to the steelworks. The alternative system favoured concentration of consumption near the basing points; and as these were likely to be important producing centres a minimising of delivery costs was likely. There is a presumption that such minimising would result in a reduction in real costs of industrial production (including the distribution of the finished products),[1] and from this angle the

[1] Where a considerable weight of steel is used, and where (as commonly) the process of manufacture in the consuming industry results in a heavy scrap production, then a location remote from steelmaking involves the transport of a heavier bulk of material than a neighbouring location, and this not only on account of the movement of the raw material (the steel) itself but of the subsequent movement of scrap. Where the market for the products of the consuming works is itself a scattered one, remote location with regard to steel must almost inevitably involve needlessly high total costs; where it is concentrated close to the consuming works it may be otherwise. The *commercial* aspect of the position, as distinct from the more broad *economic* aspect, may be very much affected by the degree of difference between the rates charged by railways for different classes of freight. And needless to say there are considerations other than transport costs which are relevant in determining the advantages of location, which it would not be relevant however to discuss here.

basing-point system is the better. Its advantage, however, naturally grows with the distances involved in delivery; it was thus rather more valuable in Germany than in Britain and much more so in the States, where no maker could ever seriously contemplate selling at a uniform delivered price. It was also obviously adapted to an industry dominated by one or two large producing areas, as the American industry was for long dominated by Pittsburg, and the German by Westphalia and later on to a smaller degree in a few branches by the minette area. In Britain, where price agreement followed upon the conflict of a considerable number of producing areas, and where makers had consequently in competitive conditions obtained their highest prices (F.O.T.) locally, it was otherwise. A régime of uniform delivered prices possibly reflected roughly the experience of the industry, and probably changed very little the relative advantages of different consumers (though Belfast, Birkenhead and Barrow ceased to obtain shipbuilding steel more cheaply than Glasgow).[1] Hence the acceptability of this feature of British policy to both makers and users. Users never welcomed price control, but there would have been a particular outcry had established advantages been greatly varied (as by a basing-point system), and since the disturbances of such advantages could not have had a uniform effect on all steelmakers[2] there would have been dissidents among producers as well as among consumers. The historical basis of the British system is thus clear; it was the system which promised the greatest immediate stability. Its implicit dangers were possibly not considered; certainly nothing was done to cope with them; and this remains, as will be seen, one of the important unsolved problems of the industry.

The British system was probably less satisfactory in the long run than the German and American not merely because, unlike

[1] Above, p. 343.

[2] The customers of some firms would have gained on balance, the customers of others have lost. And since all makers would have to charge the same price to any single customer though not the same price to all customers, it would have been difficult for the firms whose customers were now less well off to have secured custom among the firms who were better off under the new régime.

them, it encouraged dispersion of consumption, but because it was likely to be more inimical to the shifting of production when raw-material circumstances favoured this. Both systems could be managed deliberately to hinder locational change. But if a new basing point were established where raw materials could be cheaply assembled, consumers would be attracted there; whereas if, in the British system, a particularly low price were established within the district where low-cost production was possible, this would not necessarily draw consumers very close to the producer, since each price district was extensive. In actual practice the British system never did fix particularly low prices for low-cost districts; normally prices for the Sheffield, Lincolnshire, Scots, North-East Coast and South Wales areas were similar or within a few shillings of each other. Substantially this was its object. Such price differentiation as occurred was usually designed to exact, quite reasonably, higher prices from consumers in areas (such as Aberdeen) remote from any producer.[1]

It may be added that while it is broadly true that the British system did not noticeably affect the relative competitive strengths of different consuming areas, there have been periods in which this was by no means so. For after 1923 the price changes in the different districts were for some years markedly dissimilar, and changes in competitive advantages thus certainly occurred. In 1923 prices for plate were uniform in Scotland, Ireland and the North-East Coast, and 5*s*. higher in the Sheffield district. In 1924 prices in Scotland, Ireland and Sheffield were 10*s*. above those ruling on the North-East Coast; in 1925 Scots prices exceeded those on the North-East Coast by an amount varying from 12*s*. 6*d*. in April to £2. 5*s*. in November, and Sheffield and Ireland charged 5*s*. more still. In subsequent years Sheffield, Scotland and the North-East Coast had uniform prices, while Ireland paid 7*s*. 6*d*. or 10*s*. more. This instability was clearly disturbing. But it was not inherent in the British system as distinct from the basing-point system; it was merely

[1] To this extent the modifications of 1923 brought the British system closer to the basing-point system.

an outcome of imperfect agreement in the industry, and perhaps of some initial conflict of interest over the treatment of Belfast. The low prices on the North-East Coast in 1924–5 resulted from local competition, with the South Durham Company outside the Association. The price cut which was thus induced on the Tees was accepted by other areas from early in 1926;[1] no doubt it was irresistible.

The second change in the post-war price control to be remarked was that prices for the common products were now fixed net for merchants as well as consumers. It has been seen that before the war makers were inclined to handle the selling of their products more fully, whether by organising selling departments or by giving exclusive agencies for particular areas to a few merchants. The war enlarged the scope for direct selling, if only because of the system of priority certificates which brought makers and users more commonly together, lessening thereby the value of the merchants' contacts in the home market. Hence after the war the makers felt strong enough to antagonise the merchants, who under the new régime could only obtain a profit in selling large tonnages of heavy steel by securing quick deliveries, for which a premium would be paid. They might do this in two ways—either by holding stocks, or by their knowledge of the rolling programmes of makers, which allowed them to spot the firms which could handle a particular order expeditiously. Makers usually held that stock-holding was a legitimate function, but the second activity increased their antipathy towards the merchant, who obtained a premium for quick delivery which they thought was due to them; nevertheless, so long as no other clearing house for orders existed the merchants clearly were performing a useful service here. But the extent of this business was limited, and the merchant firms rightly judged that their trade in British steel would continuously shrink.

No doubt this drove them to make what they could out of the trade in foreign, particularly Continental, steel; and it is seductive to accept the view, expressed vigorously by some of

[1] The price movements are dealt with subsequently, p. 426.

the merchants themselves,[1] that by a more tactful policy the British makers might have enlisted the selling experiences and the export contacts of British merchants on their own behalf, as the German producers had done. Possibly something *was* lost; many of the smaller British firms could scarcely afford effective selling organisations, and some, in face of a policy which antagonised the merchants, took no steps to replace them. But the contrast with the German structure was not apt, because the German makers' relations with the merchants depended in the home market upon the effective institution of central selling and the absence (owing to the tariff) of a significant import trade, while in export markets the merchant who covenanted to sell German goods only knew he would have a low-price product to handle.

5. FINANCE

The events of the war and inflation years left the industry far more heavily burdened with interest charges than it had been in 1914. For various reasons it is impossible to illustrate the change at all precisely, but the following figures, based on the accounts of the chief public companies for whom fairly satisfactory comparative statistics exist, probably give a fair indication of the trend of events.

Table XXVIII

Nominal Value of Shares and Debentures of Iron and Steel Companies[2]

	Jan. 1914	Jan. 1921	Jan. 1925
Ordinary shares	33	72	78
Preference shares	2·5	6·2	6·6
Cumulative preference Shares	18	34	35
Debentures, etc.	19	31	42

[1] E.g. H. J. Skelton, *Economics of Iron and Steel* (1924 ed.), p. 544 sqq. and the *Annual Reviews* of Wm. Jacks and Company.

[2] The figures come mainly from the *Stock Exchange Official Intelligence*, 1914, 1921 and 1925, but other sources have also been used to facilitate comparison. An effort has been made to avoid double counting where some of the shares of one company were held by another. The list does not of course purport to cover the *whole* of the industry, for records are not available.

Till 1921 the volume of issues which bore a cumulative liability thus rose more slowly than that of issues which were free from this; but the balance was kept virtually even between three types of shares in regard to issues which were *sold*; the proportionate advance in ordinary shares was largely made up of bonus issues. From 1921 onwards the balance shifted, and the most notable change was the growing burden of debentures. There were two other important changes apart from those in the *volume* of issues. First, an appreciable rise in the rate of interest on fixed-interest issues. Debentures had commonly been raised at 4 or 4½ per cent before the war; after the war 7½ and 8 per cent were common. This was partly because many new issues ranked second to former issues, and were thus less well secured, but there was a rise irrespective of this. Bolckow's, for example, raised new debentures in November 1920 at 8 per cent to replace a 4 per cent issue which was redeemed.[1] The rise in the fixed-interest burden on the industry was thus far greater than the table suggests. The second change was that a large proportion of the new debentures was for short periods only—from three to seven years. Some firms had raised money in this way before the war, and had been able to do so cheaply; but it was not common among firms in the common-grade trade.[2] It became so after the war; and it was not now associated with low interest rates.

It has often been argued that most if not all of the increase in the capital burdens of the industry was virtually imposed on firms by the Government, inasmuch as the extensions of plant which occurred at this time were the result not of private initiative but of Government pressure. "During the four years of the war", Sir William Larke has said, "the industry increased its capacity by no less than 50 per cent, and it emerged crippled in its financial resources because in the aftermath of the war it was left with a capital commitment which it had incurred to serve national needs, for which there was no peace-time employment."[3] This claim is not tenable save in a very modified form.

1 *St. Exch. Offic. Intel.* 1921, p. 1312.

2 Bolckow's had habitually done this, and sometimes raised money at 3½ per cent, though all that outstanding in 1914 carried 4 per cent.

3 *J.I.S. Inst.* 1936, I, p. 498.

In the first place not all the increase of capital burden arose from the building programme; much was the result of amalgamations, which, save in a few instances, were not in any sense sponsored by the Ministry of Munitions. Some of these amalgamations, by increasing the links of the industry backwards with coal or ore mining or forwards with engineering, involved an addition to the capital of iron and steel firms which was in part merely a transfer from another "industry", though the prices paid for the businesses acquired were no doubt usually higher than they would have been in 1914. But many of the amalgamations united firms both already making iron or steel and led to an easily traced increase in interest, particularly in fixed interest, burdens. To take a few examples. In 1920 Guest Keen's bought Lysaght's ordinary shares (of which there were two million, three-fourths of them bonus shares issued in 1919), paying one Guest Keen ordinary share plus one and one-third cumulative preference shares for each ordinary share purchased.[1] In the same year Baldwin's paid twenty ordinary and eleven cumulative preference shares (newly created) for every forty ordinary shares of the British Mannesmann Company, increasing thereby the fixed-interest indebtedness of the industry though reducing its total nominal capital.[2] In the same year John Summers, in buying the Shelton Company—not hitherto very successful—gave one $7\frac{1}{2}$ per cent newly created cumulative preference share, together with 5*s.* in cash, for each ordinary share.[3] And Bolckow's, to give one further instance, paid £725,000 cash along with over £500,000 in ordinary shares in purchasing Redpath Brown's ordinary shares in 1923, and the cash was specifically obtained by an issue of 6 per cent debentures.[4] It is immaterial in this context whether these increases reflected war-time expansion of capacity, for the purchases showed the value put upon the purchased concern after the

[1] *The Times*, Jan. 14, 1920.

[2] *St. Exch. Offic. Intel.* 1921, p. 1314.

[3] *St. Exch. Offic. Intel.* 1921, p. 1370. Shelton had never paid more than $7\frac{1}{2}$ per cent on its ordinary shares.

[4] *I.C.T.R.* Feb. 23, 1923, p. 298. For each £1 share £2 in cash plus $1\frac{1}{2}$ ordinary shares was paid.

expansion and in circumstances unaffected by the activity of the Ministry of Munitions. The extent of this kind of thing is not known precisely, because the relation between amalgamations and capital issues was not always made specific as in these instances—but it was manifestly important.

It is incorrect, then, to suppose that interest burdens were increased solely as a result of plant expansion. It is equally erroneous to suppose that plant building in these years was undertaken entirely under pressure from the Government. In its literal sense this is not subject to controversy. Much of the building which occurred in 1919–21 was made under post-war contracts, and the Ministry did not involve itself in new contracts after the war. Final decisions here were all made by the firms concerned on their own responsibility alone. Many of the schemes may never have got to the stage of being discussed with the Ministry during the war at all, and some may have had a purely post-war origin. To take a few examples. Dorman Long's replaced the North-Eastern Steel Company's Thomas melting shop by an open-hearth shop in 1919, and started to reconstruct the Clarence blast-furnace plant, greatly enlarging one of the furnaces and building a new staithe to handle imported ore.[1] The United Steel Company promoted a subsidiary company in 1920 to build semi-continuous re-rolling mills adjacent to their continuous billet mill which was completed in that year.[2] Whitehead's started building at Newport about the same time; and Colville's started to erect a large heavy plate mill at Clydebridge.[3] Baldwin's were negotiating at the close of 1919 for land on which to build a sintering plant.[4] Guest Keen's bought land in the Ebbw valley early in 1920 in order, so it was said, to erect a gigantic combined works above their Rogerstone works.[5] The scope of the building, whose planning was not completed till after the war, was clearly considerable;[6] in addition there was much plant finally determined upon, ap-

[1] *The Times*, Dec. 18, 1919.
[2] *I.C.T.R.* March 5, 1920, p. 335.
[3] *I.C.T.R.* April 22, 1921, p. 570.
[4] *The Times*, Oct. 11, 1919.
[5] *Ibid.* Aug. 14, 1920.
[6] The list given does not of course aim at being comprehensive.

proved of by the Ministry, and sometimes contracted for, during the war whose construction did not start until after the armistice; the heavy plate mills at Bolckow's and at Appleby were both in this category.

None of this plant building, then, was imposed on firms by the Government. But had makers really any option? Were the steps taken after the war really necessary complements to steps taken during it? If you had built steel-melting shops, it might be said, you must build rolling mills to use the steel and blast furnaces to supply the raw materials. This was not the view taken by contemporaries. "It was not altogether a disadvantage", argued the *Iron and Coal Trades Review* early in 1919, "that some of the schemes (for new plant) should be matured in the light of post-war experiences."[1] Modifications were possible.[2] And manifestly it would have been crazy to build new plant when costs were exceptionally high if there were no prospects of markets; it would have been still more crazy in the circumstances to buy coal mines and blast furnaces as many firms did, Baldwin's, Dorman Long's, and South Durham, for example,[3] to safeguard their supplies of raw materials, or to buy other steelworks if your own were unlikely to be fully employed and if liquid resources were likely to prove competitively important. The plain fact is that steelmakers expected to be able to use their new capacity profitably; nothing else can explain their readiness to immobilise resources, and they did not attempt to hide their optimism. Arthur Dorman, for example, strongly urged all ordinary shareholders and employees in his firm to take up the new shares offered in March 1920, and after these had fallen sharply in value within a few months he repeated his

[1] *I.C.T.R.* leader of Jan. 3, 1919, p. 24.

[2] Some firms did drop ambitious schemes; Hickman's, for example, had a plan for expanding up to a capacity of close on 500,000 tons a year at Bilston: *I.C.T.R.* Feb. 15, 1918, p. 180 (leader).

[3] Dorman's bought the Carlton Iron Company in 1919, which brought more blast furnaces, iron mines and collieries into the concern; South Durham bought Cochrane's and the Seaton Carew Ironworks (through a newly created company, the East Coast Steel Corporation); Baldwin's bought new coal mines early in 1920; in all instances it was said the step was vital for securing raw materials. Reports of meetings in *The Times*, Jan. 3 and April 20, Nov. 27, and May 10, 1920.

assurance that "given normal working conditions we could earn profits to pay a fair dividend on our increased capital". Depression, he thought, would be short: "the world's wants were still large and unsatisfied."[1] It was the same at Ebbw Vale. In May 1920 they announced that they were to start making "the cheapest steel in the world". "We are out of the wood...we are enjoying prosperity."[2]

The steelmakers' faith in their prospects was very widely shared outside the industry. *The Times* in its *Trade Supplement* sponsored the view that "nothing but extravagant labour demands can prevent the biggest and longest sustained spell of activity in the annals of the British industry".[3] Shipbuilders on the Clyde bought up steelworks at very inflated prices; the industry's shares sold well; its new issues were usually over-subscribed until the latter part of 1920. There was plenty of money for investment in the inflation years, and it went readily into steel.[4] Nor are the reasons which prompted this optimism obscure. As the war advanced, the steelmakers saw in the destruction of capital goods—ships, railways, etc.—a vista of many years of replacement work before them.[5] They were also convinced that German competition would be crippled by the loss of Lorraine. "It was with France rather than with Germany that we should have to reckon in the near future",[6] and this seemed a minor threat, for the French lacked the selling contacts and metallurgical traditions and repute of the old rival; in any case it would be years before they and the Belgian makers could set their devastated works running and get into their stride. Moreover, it was unlikely that they would be such

[1] Meeting, reported in *Econ.* Dec. 18, 1920.

[2] *The Times*, June 17 and 20, 1920.

[3] *The Times*, *Trade Supplement*, Feb. 1919, p. 264.

[4] The ordinary shares were mainly offered to existing shareholders, and taken up readily; the other issues were often handled by London houses. Some of these were new, established during or since the war to promote British trade. Some had steelmakers on their boards, and some may well have had semi-official backing. E.g. the British Trade Corporation, whose board included Sir Arthur Balfour and Sir Wm. Peat, and which banked with the Bank of England. It handled, among other issues, Bolckow's debentures.

[5] Cp. *The Times*, Oct. 24, 1918 (Meeting of Steel Company of Scotland).

[6] *I.C.T.R.* Jan. 3, 1919 (leader).

malevolent rivals as the Germans had been—"there would be little fear in the future of the sinister methods used by the Germans".[1] The home market for semis was thus likely to be captured. But if it proved otherwise, surely the prospects of a tariff had brightened as a result of the war? Its advocacy could now be based on the loftiest of motives. A strong and extensive steel industry was vital for national security. "The Government was pledged to the hilt to secure, at the very least, a fair field for key industries against any unfair competition."[2] Markets, then, were to be better than before the war; competition less efficient, less ruthless, and less privileged; and improved plant was bound to turn the scales still further in the British makers' favour, offsetting the growing disparity in the price of labour. Doubtless each firm expected it would gain more than its home rivals; plant improvement was a means of taking a larger share of the British trade, or even of keeping a share in face of others' improvements, not merely of gaining from foreign rivals. But the latter expectation was there.

Capital burdens incurred by new plant building *after* the war were thus mainly the outcome of the belief that demand was rising and that trade could be profitably expanded, and to a less extent they were protective measures to cope with home competition. This is indirectly borne out, it may be remarked in parenthesis, by the willingness shown by some steelworks to buy others at inflated prices, examples of which have been given. Should the same conclusion be drawn also concerning expenditures incurred *during* the war?

Probably it should. Sir John Hunter, Director of the Steel Department from August 1916, once said in evidence at an Assessment Appeal that "the war extensions would not have been undertaken voluntarily. No steelmakers expressed confidence in the possibility of their commercial utilisation after

[1] *Ibid. loc. cit.* and *The Times*, June 20, 1918 (Meeting of Ebbw Vale): "the unscrupulous dumping process of the Germans" had nearly driven our heavy steel trade "on the rocks of ruination. We can now expand without fear of unfair treatment."

[2] *I.C.T.R.* Jan. 3, 1919; also *Rep. Dept. Comm. on Steel...after the War*, pp. 14 sqq., and *The Times, Trade Supplement*, March 1919, p. 290: "statesmen are pledged to prevent dumping if it is attempted."

the war."[1] This cannot mean literally that all makers thought there would be no profitable market for the product of new capacity, not only for the reasons just given, but also because a few of the war schemes (Appleby, for instance) had been actually planned before the war. No doubt makers were all sceptical as to the commercial wisdom of war-time building, but not all for the same reason; many were possibly concerned mainly with the rising *cost* of new equipment. Now their fears were appreciated by the Government, and makers were assisted financially in three ways: loans were made on favourable terms, specific grants were given, and taxation was imposed with some indulgence.

As to the grants, Hatch said it was the Ministry's object to supply makers with up-to-date plants at pre-war costs. But this principle was not applied rigorously.[2] Colville's, for example, only contracted to accept new plant put up at their works at its scrap value at the close of the war; ultimately they bore 25 per cent of the cost. The instance is possibly not representative, though very illuminating on the principles involved.[3] The general practice, according to an official report, was for the Ministry to bear from one-third to one-half of the cost of new plant. But sometimes it bore less. To an expenditure of £5 millions on coke ovens, for example, it contributed £1·25 millions.[4]

Makers thought they had a grievance over taxation. But the control prices allowed them to make good profits, and in assessing liability for excess profits duty generous allowances were made for depreciation. "The E.P.D. was open to grave doubts in economic theory", according to the *Iron and Coal Trades Review*, "but has been worked out very fairly in practice,

[1] *I.C.T.R.* Sept. 23, 1921, p. 456. [2] Hatch, *op. cit.* p. 39.

[3] *I.C.T.R.* Sept. 30, 1921, p. 491. This refers to an expenditure of £300,000; but this does not cover the *whole* expenditure at Colville's in the war. The same principle, that the Government should stand three-quarters of the cost, also applied to the case of Bolckow's in respect of changes costing over £750,000: *I.C.T.R.* Nov. 23, 1923, p. 782.

[4] Hatch, *op. cit.* p. 98; *S.C. on Nat. Expenditure, 1918, 1st Rep.*, p. 13. Some makers were perhaps influenced by fear of State activity; they may have preferred to take serious risks rather than leave plant building to the State (save in very exceptional circumstances) and so weaken the hold of the individualist system.

while the Income Tax is theoretically the most perfect tax, but the law has been interpreted oppressively".[1] In one instance depreciation amounting to 57 per cent over three years was allowed in assessing E.P.D. on new premises.[2] The standard profits allowed in industry in general before E.P.D. was taken was 6 per cent (for companies). The steel industry was allowed a standard rate of 8 per cent on old capital and 11 per cent on new, subject apparently to special further allowances for depreciation. This policy allowed the accumulation of sums for investment, and it may have been dependent on the occurrences of such investment.

How far profits were in fact re-invested cannot be traced accurately; the most that can be done is to trace the growth of dividends and the accumulation of new capital implied by the issue of bonus shares, etc. For a representative sample of twelve firms,[3] none of them armament firms, whose total issued ordinary share capital amounted to £12 millions in 1910, the yield on these ordinary shares (before deducting income tax, and including interest on bonus shares but not their values) totalled £5·2 millions in the five years from 1910 to 1914 and £10·3 millions from 1915 to 1919. Six of the firms made large issues of bonus shares just after the war, amounting in nominal value to £7·5 millions in respect of the shares issued in 1910. The ordinary shares of three others (one a bonus-issuer) whose nominal value was £1·45 millions were bought for cash in 1919–20 at values representing an increase of £2·25 millions (an eloquent testimony to the hopes placed in steelmaking at this

[1] *I.C.T.R.* June 14, 1918, p. 610.

[2] *Ibid.*: and to take another instance, Darlington Forge were allowed to depreciate their new plant, erected in 1917, by 47½ per cent during the period of control out of profits: this was the Ministry's contribution. See Law Report, *I.C.T.R.* Nov. 20, 1925.

[3] The twelve firms were Baldwin's,* Bolckow's, Cargo Fleet, Dorman Long,* Consett,* Ebbw Vale, Guest Keen's,* Lanarkshire Steel, Lysaght's,* Pearson Knowles,* Steel Company of Scotland, and Stewarts and Lloyds'. Those starred issued bonus shares; Lanarkshire, Pearson Knowles and the Steel Company were bought for cash, Lysaght's for shares. No account has been taken of bonuses which were concealed, as it were, in the offer of new shares on ostensibly good terms, nor has any account been taken of the remarkable incident when the Northumberland Shipbuilding Company, having offered to pay £3 a share for all Baldwin's ordinary shares, paid £850,000 in cash to the shareholders as damages rather than conclude the deal: *The Times*, Nov. 30, 1920.

date). The ordinary shares of another were bought by an exchange of shares, which at the time represented a rise in value of over £4 millions on share holdings whose value in 1914 was £400,000. The bonus shares and appreciated share values represented mainly undivided profits used for some form of investment, whether within or without the industry.[1] These are only rough indications, but they show unmistakably that taxes and price control left the industry with substantial profits for re-investment.

While steelmakers did not set out, even during the war and under Government pressure, to finance plant building beyond the point at which they expected a reward, whether by increasing profit or avoiding loss, nevertheless they did involuntarily make a greater capital outlay than was expected, which doubtless accounted for some of the increased interest burden, in particular for the increase in short-term debenture issues. This involuntary burden was the result of erroneous forecasts of price movements, whereby the costs of extending plant were seriously underestimated. Firms may have suffered a little from this during the war, but they suffered far more after the Armistice in the period before inflation was checked in England in the spring of 1920, and when the post-war speculative demand for all sorts of capital goods was at its height. Some firms were doubly "caught"; for in their anxiety to be free from Government interference they sought to terminate contracts whereby the Treasury bore a proportion of the cost of construction work in progress, and to replace proportionate payments by an immediate lump sum. They soon found they had made bad bargains,[2] while the Treasury was with reason content. It was stated in Parliament that out of forty contracts for new steelworks outstanding in November 1918, seventeen had "break" clauses, but liquidators had obtained better results by private negotiation than by invoking these clauses.[3] How much was

[1] It is irrelevant in this context that the *value* of the investments often proved impermanent.

[2] Information has been obtained from the directors of firms concerned.

[3] *I.C.T.R.* Nov. 7, 1919, p. 616. Some firms held that the Government failed to keep its bond. Bolckow Vaughan's was among them, and took its case—involving a claim for over £500,000—to court. The judgment was that the contract became

involved by this kind of mistake is not known in the least. An error in forecasting the costs of new plant amounting to a small percentage only might of course increase the new indebtedness which the plant expansion involved by a much higher percentage, for the contribution to be drawn from profits and reserves was unlikely to be very elastic. Firms probably denuded themselves of working capital to meet unexpected costs of new equipment, and borrowed more from the banks to fill the gap. By 1924, indebtedness to banks had commonly taken the form of debentures,[1] and it may well be that the bulk of the new short-term debentures issued between 1920 and 1924 represented involuntary burdens; though these were not, as will be apparent when the price and cost movements surveyed earlier are borne in mind, the outcome solely of misjudgments concerning the cost of new plant. By the close of 1920 it was evident that makers had been wrong in their guesses concerning the future of demand and of competition.

So after the imperative needs of war and the confusing enticements of peace had had their day the steel industry faced competition with increased capacity and better equipment; yet it had not undergone the radical adaptations of location needed to minimise costs, fuel was still used in a prodigal manner, and production remained subdivided so that the maximum use of labour-saving devices was precluded; vertical integration was still more common than horizontal, and little advance had been made to internal homogeneity and stability. And while the old weaknesses had thus been very incompletely, where at all, remedied, the industry had new problems to face—costs of coal-getting and of labour had risen, there were heavy new debts to bear, and a dearth of ready money.

nullified since the Government had undertaken to remit a tax which it forthwith had dropped in favour of another—the Munitions Levy of 1916. The Government held it had paid in other ways: *I.C.T.R.* Nov. 23, 1923, p. 782.

[1] This is well known for some instances; and a glance at company accounts shows that by 1925 a remarkable volume of debentures (well over £10 million) was secured by trust deeds to important banks—in particular to Lloyds, Barclays and the National Provincial. There were of course still bank loans which had not taken this form; they constituted a type of debt not accounted for in Table XXVIII.

Chapter XV

'THE BLACK DECADE'
1921–1931

1. THE RETURN OF COMPETITION

As 1920 closed, the flow of exports from Britain dwindled and imports flooded in. Less than 200,000 tons of iron and steel left in December, 160,000 tons came in. Throughout the next year it was the same story, and in tonnage the imports over the year, coming mainly from the Continent, were a bare 50,000 tons below the exports. In value there was a great difference; but the pre-war situation was visibly returning, and from this time on, though the balance occasionally turned more favourably, it became increasingly manifest that the degree of change which had occurred in the industry—a characteristic compromise, the apologist might suggest—was quite inadequate to restore the competitive strength of common-grade steelmaking in Great Britain. The handicaps under which it had been expected that the Continent would labour proved lighter than had seemed likely, while the old advantages were amplified and augmented.

Table XXIX gives the export statistics up to 1931. If they are compared with the pre-war figures it is to be borne in mind that, by the provisions of the Peace Treaty, Lorraine and part of Upper Silesia were permanently separated from Germany, and the Saar temporarily, while Luxemburg was to remain outside the German customs union. But all these areas had free access to the German market for five years, and in those years and subsequently have exported much to Germany: such trade did not figure in the pre-war figures. While this was not negligible, it does not affect the general bearing of the figures.

By 1922 the Continental exporters had, as a group, almost their pre-war share of the export trade. They lost ground in 1923 mainly on account of the policy of passive resistance during the occupation of the Ruhr; but in 1925, when the total trade had for the first time passed the pre-war figure, they had

well surpassed their pre-war maximum while Britain was still behind, though her export of rolled products was just at the 1913 level. The relative positions did not subsequently change much until the onset of the depression, when Britain lost far more

Table XXIX

Exports of Iron and Steel 1920–31 (000 tons)

	U.K.	Germany	Belgium and Luxemburg	France‡	U.S.	Total
1913	4934	6401*	1479†	751	2907	16472
1920	3251	1700	921	871	4709	11452
1921	1697	1602	912	1602	2172	7985
1922	3397	2518	1727	2937	1931	12510
1923	4318	1308	2496	2184	1944	12250
1924	3853	1535	3261	2776	1711	13136
1925	3731	3214	3065	3949	1678	15637
1926	2988	4828	3708	4128	2063	17715
1927	4196	4322	4600	5591	1943	20652
1928	4260	4648	4493	4975	2356	20732
1929	4380	5492	4521	4213	2487	21093
1930	3160	4472	3857	4015	1629	17133
1931	1979	3954	3300	3546	840	13619

* Including Luxemburg and the Saar. † Excluding Luxemburg.
‡ Including the Saar from 1925.

than her Continental rivals. The American trade, it will be remarked, which had shot up during the war, fell away in face of the returned European competition.

The course of the British import trade, and the more detailed analysis of the export trades, reveal clearly the identity of pre- and post-war trends which these figures suggest. The broad features of the import trade are shown here, along with the figures for the Continental producers.

Table XXX

Imports of Iron and Steel (000 tons)

	1913*	1920	1921	1922	1924	1927	1929	1931
U.K. ...	2231	1108	1640	881	2429	4406	2822	2852
Germany	305	314	665	1828	1260	2218	1438	830
Belgium	888	840	514	500	560	639	978	472
France	172	1091	792	760	688	127	255	358

* Pre-war boundaries.

By 1924 the pre-war level had been passed in Britain, and imports remained above it for the remainder of the period. By 1924 they also exceeded once again the combined imports of the Continental makers; and if they did so less now than before the war this was almost wholly the outcome of the Peace Treaty, which turned the domestic pre-war trade of Luxemburg, Silesia, Lorraine and the Saar with Germany into international trade.[1] There was a continuous steep rise of British imports till 1927, but at its climax this reflected the coal strike of 1926. Possibly the tonnage for 1929 was brought low by the greater attraction of other markets for Continental makers during the boom; the early years of depression witnessed a slight rise again. As before the war, steel semi-products accounted for about half the total, after the abnormal early years. Pig iron was slightly, steel bars and shapes much, more important than before the war; girders and plates, wire and tubes, held their place; steel castings and forgings fell off.[2] The bulk still came from the Continent, with Belgium surprisingly more important (see Table XXXI, p. 396).

The composition and direction of the Continental export trades were naturally affected by the territorial adjustments of the Peace, but otherwise the war changed little. In the British trade pig iron became much less important, exports of rails and girders were persistently lower than before the war, and the plate trade was the only heavy trade to expand beyond the 1913

[1] E.g. in 1924 the Saar exported 258,000 tons to Germany, Alsace-Lorraine 613,000, and Luxemburg 153,000: Polish exports do not affect Table XXX.

[2] Here are the details:

	1913	1924	1929	1931
Pig iron	217	308	153	307
Blooms, billets and slabs ...	513	708	578	532
Sheet and tinplate bars ...	345	380	419	729
Wire rods	95	74	125	75
Hoops and strips	72	36	173	139
Iron bars, rods, shapes ...	200	255	186	120
Steel	134	138	390	348
Girders	109	89	141	116
Heavy plates	135	123	153	116
Sheets	35		34	28
Tubes	52	37	78	62
Wire	54	46	72	51
Castings and forgings ...	34	10	19	8

level.[1] Re-rolled products, which formed 55 per cent of the 1929 export, were the only ones which rose above the 1913 figures, tubes and uncoated sheets being much larger. The German trade returns reflected the loss of Luxemburg, Lorraine and the Saar, exports flourishing least where the low minette costs had been important. Thus exports of heavy semis and structural steel, and (not so markedly) of bars, rails and pig iron, revived slowly, and the bar trade alone approached its pre-war scale. But the plate export, never a leading product in the south-west, touched 65 per cent of its pre-war level in 1925 and 90 per cent in 1929,

TABLE XXXI

Origin of Imports to Great Britain

	1924	1927	1929	1931
Belgium and Luxemburg	1414	2579	1710	1481
France	436	827	308	435
Germany and Netherlands	369	732	562	471
Sweden	73	77	74	32
U.S.	64	80	70	13

being treble the British export. Re-rolled products—sheets, wire and tubes—were with minor exceptions[2] the only steel products to exceed the 1913 levels, but they depended much less than the British on imported semis. They were symptomatic of the growing importance of skill and experience in the Westphalian economy, though also of the expansive character of the world market for these products. What the Germans had lost passed to their rivals; the Luxemburg trade figured (from 1922) in the Belgian returns, the trade of Lorraine and (from 1925) the Saar in the French. Both French and Belgian exports were dominated by semi-products, bars, rails and structural steel. France exported a lot of pig iron, mainly to Germany and Belgium. Highly finished re-rolled products were a small part of these exports, though there were signs of change, particularly

[1] These heavy trades together formed only 15 per cent of the English export in 1929.

[2] Sleepers and fishplates, and some more finished goods (e.g. screws).

in Belgium.[1] The content of the American export is, for reasons explained earlier, of less interest than the Continental; it is notable for the falling off in pig iron, semi-products, rails and wire, while exports of sheets and strip rose.[2]

British exporters were now predominant, though increasingly challenged, in the tinplate and galvanised sheet trades alone, and there were few markets geographically where they predominated. In Australasia alone, helped by preference, the British seller met little save local opposition. In South Africa

[1] The Belgian export of coated sheets was 16,000 tons in 1924, 104,000 in 1929; of plates and sheets, 322,000 tons in 1924, 575,000 in 1929.

[2] The figures for 1913 and 1929 (000 tons) were as follows:

	U.K.		Germany		France	
	1913	1929	1913	1929	1913	1929
Pig iron	*1124*	545	*857*	433	*113*	573
Ingots, billets, sheet bars, etc.	*4*	13	*701*	468	*320*	800
Steel bars, rods	*251*	314	*1173*	1149		1320
Girders and structural steel	*122*	88	*557*	309	*32*	232
Rails	*507*	344	*501*	245	*76*	326
Hoops, strip and skelp ...	*46*	60	—	—	*3*	95
Plates over ⅛ in.	*136*	196	*461*	414	*9*	162
Sheets and light plates ...	*141*	312	*150*	221		
Tinplates	*494*	580	*54*	81	*2*	30
Galvanised sheets	*762*	712				
Wrought tubes	*165*	318	*307*	368	*6*	71
Cast tubes	*235*	136	*73*	121		
Wire rod	—	—	*463*	457	*6*	208
Wire	*81*	83			*2*	48

	Belgium		U.S.	
	1913	1929	1913	1929
Pig iron	*17*	121	*287*	54
Ingots, billets, sheet bars, etc.	*159*	455	*231*	43
Steel bars, rods	*650*	1488	*231*	200
Girders and structural steel	*96*	605	*367*	400
Rails	*165*	188	*458*	146
Hoops, strip and skelp ...	—	171	*314*	202
Plates over ⅛ in.	*196*	575		216
Sheets and light plates ...	—	—	—	174
Tinplates	*9*	104	*73*	259
Galvanised sheets			*115*	152
Wrought tubes	*10*	32	*282*	291
Cast tubes		32		47
Wire rod	*55*	393	*75*	42
Wire			*138*	42

and India British makers held half the trade, in the Argentine a third; less than before the War. The market for British sheets, plates, bars and pig iron remained world-wide,[1] but for other products—including wire and tubes—sales outside the Empire were slight. A large part of the German export still went to Europe, but less than half to markets whose location conferred an advantage; 20 per cent was sold either in Great Britain or other parts of the Empire. Belgian sales were amazingly world-wide. Only 14 per cent went to the contiguous markets of France, Germany and the Netherlands in 1929; the rest was sent to markets for which the Belgian makers were no better located than the British. Nearly a quarter was sold in Great Britain itself; another seventh in the Empire; and in the States Belgium sold more than any other country.[2] The French trade was dominated by sales to Germany, Belgium, Great Britain, Switzerland and Italy (which together accounted for 72 per cent of the trade in 1929) and to the French Empire (which took 10 per cent). Outside these markets, which apart from Britain were in one way or another privileged, the trade was relatively slight, though it grew from 600,000 tons in 1925 to nearly 900,000 in 1929. The American trade, save in a few specialities, remained centred in Canada, South America, the Caribbean, and the Far East.[3]

Such then were the main trends in the export trade. Before examining their causes it is convenient to set out the main features of market developments in these years.

The only comprehensive guide to variations of consumption is to be found in the statistics of production. The broad movements in world consumption are shown, with some exaggeration

[1] In 1929 exports of these commodities made up 64 per cent of the total British export to foreign countries.

[2] As far as the statistics guide—they are incomplete—14 per cent went to unadjacent European markets, 14 per cent went to India and the Far East, 5 per cent to South America, 5 per cent to Africa, 2·5 per cent to North America.

[3] The following is a crude index of the geographical range of different exporting countries in 1929:

	U.K.	Germany	Belgium	France	U.S.
Countries taking 25,000–49,999 tons	5	9	4	8	0
Countries taking 50,000 tons or over	25	23	24	12	12

of the rise,[1] by the totals in the following table; the subdivisions do not, of course, indicate national consumptions.

TABLE XXXII

Ingot Production (million tons)

	Total	U.S.	Rest	N.W.[2] Europe	G.B.	Rest of British Empire	Japan	Russia	Rest of Europe
1913	75	31	44	25	7·7		0·24	4·2[3]	5·4
1917	81	45	36	19	9·7		0·78	—	—
1920	71	42	29	14	9·1		0·83	0·16	3·6
1921	44	20	24	14	3·7		0·85	0·18	3·4
1925	89	45	44	25	7·4		1·3	1·8	5·6
1929	118	56	62	34	9·6		2·3	4·6	8·4
1931	68	26	42	23	5·2	1·7	2·0	5·0	5·9

Save in 1917 and 1920 the American column might almost be considered as a measure of domestic consumption. The third column shows how completely the hopes for a large reconstruction demand were falsified. During the post-war boom consumption outside the States was only three-quarters of the pre-war level, and it was not until 1925 that it fully recovered. Thereafter until 1929 consumption rose appreciably, more rapidly outside than in the States; and it fell less in the slump.

The regional distribution of demand for steel in general is not known precisely; still less for particular steel products. In

[1] Exaggeration because cast and wrought iron were being less used.

[2] "N.W. Europe" is made up of the following subdivisions:

	Germany	Saar	Luxemburg	France	Belgium
1913	17·3[1]		1·3	4·6	2·4
	15·3		1·1	2·2	0·0
1920	8·4	0·7	0·6	3·0	1·2
1921	8·9	0·9	0·7	3·1	0·8
1925	12·0	1·6	2·1	7·3	2·5
1929	16·0	2·2	2·7	9·6	4·0
1931	8·2	1·5	2·0	7·7	3·1

[3] To make the figures in these columns comparable throughout, the Russian figure for 1913 has been reduced by 0·5 to allow for subsequent creation of Poland, while 1·0 has been added for the same reason to the Rest in 1913, which in fact occurs also in the German total.

many markets where British makers were entrenched[1] the recovery of demand for imports was slow, sometimes incomplete, because of the long depression of raw-material producers and the growth of home steel-industries. But several of the chief pre-war markets expanded.[2] Yet in most of these markets, sluggish or expansive, British sellers lost ground, finding some compensation in the expansion of Crown Colony markets. As regards the shifting of demand from certain products to others, here again there seems to have been little that was prejudicial to the British makers. The notable changes were a world-wide falling off in demand for rails and their accessories; a slow rise in demand for tubes (with steel replacing cast iron), and for steel in bridges and buildings, and a very big expansion in the use of plates and sheets, of strip, and of "bars, rods and shapes". In all branches of the plate and sheet trade, the chief British speciality, the British export grew proportionately less than those of competitors. In the pipe and tube trade the British exporters held their own, and the steel tube makers, using a lot of imported strip, almost certainly gained at the expense of rivals. How did the chief exporters fare in their home markets? The changes of frontier due to the war make comparison difficult. But some conclusions may be drawn from the following figures.

The British home market had risen above the pre-war level by 1924. In the rival Continental centres—taken compositely—this happened rather later; and consumption here was still not as much above the pre-war level in 1929 as it was in Britain. But there is another angle from which this must be viewed. The Peace Treaty lopped 10 per cent off Germany's population, but 30 per cent off her steelmaking capacity. If the home demand for the products of the 70 per cent of capacity which remained German in 1919 be reckoned at 8·5 million tons in 1913,[3] then by 1924 there had been a more rapid rise than in Britain, and this continued until 1929.[4] For French and Belgian customs areas

[1] E.g. Canada, Australia, India and the Argentine.

[2] Japan most notably, but also U.S., Sweden and Italy.

[3] I.e. 70 per cent of 12·38.

[4] By this date it was more clearly a real rise in home demand of value to the home producer since full custom control had been re-established.

TABLE XXXIII

Home Consumption of Finished Iron and Steel (ingot equivalents)[1]

	1913		1924		1929		1931	
	Million tons	Kilos per head	Million tons	Kilos per head	Million tons	Kilos per head	Million tons	Kilos per head
Great Britain	6·85	150	7·44	165	8·39	182	6·63	141
Germany, pre-war	12·38	184	—	—	—	—	—	—
			1925					
Germany, post-war	—	—	9·47	151	11·72	180	4·76	72
France, pre-war	4·29	108	—	—	—	—	—	—
France, post-war and Saar ...	—	—	4·91	121	6·80	165	5·51	131
Belgium	1·14	148	—	—	—	—	—	—
Belgium and Luxemburg	—	—	1·05	112	1·58	190	0·69	82
Total (Great Britain excepted):	17·81	155	15·43	150	20·10	165	10·96	94

[1] Cp. League of Nations *Memo*, 1927, p. 33, for a table on a different basis. It takes some account, not satisfactory, of pig-iron consumption, and it fails to convert foreign trade to ingot equivalents.

the converse reasoning applies; the measurement by kilos per head[1] may manifestly prove very misleading, and the home demands viewed in relation to the increase of productive capacity due to the Peace Treaty transfers were probably little if any higher in 1929 than in 1913, though notably better than in 1925. Only enlarged export trade, probably, allowed expansion of production in these areas; and the ratio of exports to home trade in France in 1929 (67 : 100) and still more in Belgium (300 : 100) exceeded the ratio for Britain (61 : 100—it had been over 70 : 100 before the war) and for Germany (56 : 100).[2]

2. NEW SOURCES OF CONTINENTAL SUCCESS

In May 1921 the National Federation presented a Memorandum to Lloyd George to expose the origin of the calamitous recession of trade which bade fair to overwhelm the industry.[3] The Government was blamed for failing to reward the patriotic expansion due to the war in accordance with its promises. Otherwise the relative weakness of the British industry was traced to adventitious circumstances outside its control. The Germans had cheap labour because their standard of living had been reduced by the blockade; taxes and railway rates were phenomenally low in Lorraine and Belgium; Belgium had cheap supplies of war scrap; and all the Continental centres were benefiting from the foreign exchanges. For the next ten years the Federation repeated and amplified this case.[4] And it was

[1] Recommended by the League of Nations *Memo*, p. 32.

[2] These figures, are, of course, crude. See pp. 329–33. They eliminate trade in pig iron, but this makes no vital difference. If the data for rails, girders, sections, pig plates, and merchant steel are isolated, which is from some angles reasonable, the British position is much weaker. Britain exported 23 per cent of her output of these, Germany 33 per cent, France 35 per cent, Belgium 68 per cent. For details of particular branches of the British trade in 1924 and 1930, see *Final Report of Fourth Census of Production*, Part II, pp. 43–4.

[3] *I.C.T.R.* May 17, 1921.

[4] See e.g. Evidence of Sir W. Larke to the Balfour Committee, *Minutes of Evidence*, Q. 6198. He was of course fully aware of the continuance of pre-war sources of Continental export strength, but regarded subsequent changes as the determining factors. "Our costs must fall if we are to compete with the Continent, whose prices are likely to rise, but not to the pre-war position when we were able to compete successfully with slightly higher prices."

undeniably plausible. But it would have seemed hardly less plausible to anyone who recalled the past to argue that the pre-war advance of the Continental producers would have continued without these adventitious aids; and although the appeal to history was rarely made, there was throughout the decade a growing weight of opinion favouring the view that, while luck may usually have favoured the Continent, the industry suffered chiefly from its own mistakes—at any rate from its faulty organisation and backward technique—or from a decline in natural advantages, above all the deterioration of its raw-material supplies. Those who diagnosed declining natural advantage regarded recession as inevitable: the industry must concentrate on special products. But the critics of the industry's organisation (a few of them "insiders") believed that, given radical reconstruction, it could hold its own despite the post-war luck of the Continental makers, which could only be temporary, and despite those older advantages which the Continent possessed after as before the war. How far were they right?

The steelmakers could rightly claim that in at any rate four respects the war gave rise to conditions which helped their Continental rivals.

First, currency conditions. While Great Britain sustained the policy of deflation adopted in 1920 and returned to the gold standard without devaluation in 1925, Germany followed an almost persistently inflationary policy up to the close of 1923, when the old currency, wholly worthless, was replaced by a new; and France and Belgium, after deflating for a short time in 1920–1, inflated until the close of 1926, and finally returned to gold with their currencies greatly devalued.

The Continental steelmakers thus obtained for a prolonged period and in an intensified degree all the advantages enjoyed by the British makers during the British inflation of 1919–20, with scarcely any of the drawbacks of the subsequent deflation, and they had some additional benefits as well. Steel prices rose in advance of the cost of raw materials, of the cost of living, and of wages; hence the money earnings of firms tended to be

high.[1] Home demand was good because it was tempting to invest in capital goods rather than to hold depreciating money values, and because the rise of prices lessened the burden of old debts and eased their repayment. The steelmakers themselves were of course subject to these influences, and invested the bulk of their earnings in new equipment or in buying up other firms, becoming nevertheless unusually lightly burdened with long-term indebtedness. The important auxiliary industries on which steelmaking was very dependent—coal mining and transport—were also encouraged and helped by the ensuing charges to improve their plant and so cut costs. In addition to all this, export demand was stimulated by the Continental inflations since the internal values of the currencies were usually higher than the external, the exchange rates being sensitive to the prospects of further depreciation. So long as conditions were not absolutely chaotic, as they ultimately became in Germany, this situation was very favourable for export trade, since prices which were profitable at home during inflation were low in terms of the currencies of countries which had stabilised, or were deflating, or were inflating but at a slower pace.

The German makers gained most dramatically from inflation, though not for so long as their western neighbours. The price history of the period, which is traced later,[2] is a striking indication of their gain; for the German industry, despite the loss of its low-cost producing areas—Lorraine, Luxemburg and the Saar—made profits in 1921–2 with home prices (in terms of gold) far below those of the franc countries. A particularly lurid view of the position is given by the fact that in English currency the wages of German skilled workers in January 1923 were below 6*s*. 8*d*. per week, though only half the pre-war level in terms of the German cost-of-living index.[3] The German inflation virtually wiped out all old indebtedness, and correspondingly raised the industry's borrowing power, as a survey of the position after stabilisation shows.

[1] For all this see the Department of Overseas Trade series of *Reports on Economic Conditions in France* and *Germany*. A valuable Italian study of the German inflation has recently been translated: C. Bresciani-Turroni, *The Economics of Inflation*.

[2] Table XXXIX, p. 427.

[3] *Report on Econ. Cond. in Germany* (1922–3), p. 99. Also below, p. 407.

TABLE XXXIV

Capital Structure of the German Industry[1]
(in millions of marks)

	Share capital	Loan capital: Long period	Loan capital: Short period	Liquid resources
1925–6	55	9	27	22
1926–7	58	12	20	20
1927–8	85	48	37	33

Figures for 1924 show an even more favourable position as regards long-period indebtedness.[2] Yet this had not involved "starving" the plants in any sense: on the contrary investment in modernising had been continuously lavish.[3]

The "franc" countries gained most from inflation after German stabilisation. The immediate post-war inflation lifted the burden of old debts but raised reconstruction costs, which were peculiarly high at the outset because of the universal demand for capital goods.[4] Moreover, the famine price of coal checked the profits of those French makers who were in a position to produce steel in 1919–20, and were not merely restoring plant.[5] In 1921 there was a short period of deflation, more acute than in Britain, which together with the world-wide

[1] The short-period borrowing reflected inflation finance: it was tempting to invest profits in plant and rely to an abnormal degree on short-period borrowing for working capital. Even investment in plant and in shares was often financed in this way. It is difficult to explain why the banks were ready to lend so much on the terms they did—ignorance of the nature of the inflationary process and the malign influences of industrialists on their boards provide the clues: Bresciani-Turroni (*op. cit.* p. 294); confirmed by other authorities. On stabilisation firms were forced to renew their short-period loans, and the banks thus regained some of the influence which they had lost during the inflation. The rapid subsequent growth of long-term loan capital is a good index of borrowing power: *Eisenerzeugende Industrie*, p. 120.

[2] The figures available for 1924 are less comprehensive than those in the table, but the proportion of long-term loan capital was in that year much less for the firms represented: *ibid.* pp. 177 sqq.

[3] *Report on Econ. Cond. in Germany* (1924), p. 130; and Bresciani-Turroni, *op. cit.* p. 201.

[4] *Rep. on Econ. Cond. in France* (1924), p. 28.

[5] Brelet, *op. cit.* p. 77. He quotes a Report of the Comité des Forges which criticised the British Government's policy in 1919–20 of charging very high export but low inland prices for coal as a "protectionist measure more effective than any tariff barrier".

collapse of steel prices threatened to upset the finances of the French industry.[1] 1922 saw the revival of inflation, albeit restrained, and the industry flourished again, but export prices were ruled by German competition. From 1924 onwards the French and Belgian exporters were determining the price, and the inflation of the next two years persistently reduced the real cost of fixed-interest payments, raised profits and stimulated new investment.[2] During this period the Germans, insensitively indifferent to the recent past, complained bitterly of the franc-depreciation in a memorandum to the League of Nations.[3]

Though the Continental producers suffered from each other's inflations, and currency instability was no unmixed blessing, they certainly had the advantage here of their British rivals, who had to cope with unfavourable exchanges (from the exporter's standpoint) and a falling price level at home, until the close of 1926. By inducing the latter the British Government's currency policy accentuated the difficulties of the industry, and the return to gold in 1925, to quote the Macmillan Committee, was "the beginning of a new series of difficulties for our trade and industry", which forced exporters to a new reduction of prices.[4] The realised price of steel plates fell by 20 per cent through 1925–6. The sliding-scale system no doubt eased the adaptation of wages to the new price level, but there was an inevitable time-lag; moreover, the construction of the scales was such that as prices fell wages became a proportionately heavier burden. The cost of coal was lowered at the close of 1925 with the aid of a State subsidy, but a stable reduction

[1] Prices are tabulated below on p. 427. For a contemporary view of this period of the French industry's development see Brelet, *op. cit.*

[2] The index number of French wholesale prices (1913: 100) was as follows:

1919	357	1923	428	1927	630
1920	511	1924	499	1928	633
1921	346	1925	496	1929	623
1922	337	1926	718	1930	543

The stabilisation of 1927–8 thus involved a relatively light deflation, and the subsequent price level was such that virtually all prior indebtedness save some incurred in 1919–20 had been lightened by the currency changes.

[3] League of Nations *Memo*, p. 93. The French had similarly complained in 1920: cp. Guy de Wendel, quoted in *I.C.T.R.* Jan. 7, 1921.

[4] *Rep. of Macmillan Committee on Finance and Industry* (1931), p. 51.

was only achieved after the strike of 1926, which by practically suspending steel production for three months involved a break of contacts which was necessarily dangerous for an industry depending much on established connexions. Other costs, e.g. taxation and transport, were less responsive. The steelmakers appear hardly to have appreciated that deflation was not only injurious but avoidable; bankers attracted the respect which the industry had always bestowed upon "the practical man".[1]

The prolonged effect of currency policies is illustrated from one important angle in the following table which traces movements of wages in relation to price levels.

TABLE XXXV

Relative Wages and Price Levels

	Wages				Prices (Wholesale)‡			
	British[2]		Rh. Westphalia[3]		British		German	
	Money	Real†	Money	Real	General	Food	General	Food
1913	7*s.* 1*d.**	100	5*s.* 11*d.**	100	100	100	100	100
1920	18*s.* 3*d.*	98	—	—	—	—	—	—
1922	10*s.* 3*d.*	80	2*s.* 0*d.*	75	—	—	—	—
1924	11*s.* 4*d.*	92	6*s.* 11*d.**	100	186	166	—	—
1925	11*s.* 7*d.*	94	8*s.* 5*d.*	101	160	167	141	133
1926	10*s.* 9*d.*	88	8*s.* 9*d.*	105	148	155	134	130
1927	11*s.* 4*d.*	94	9*s.* 8*d.*	110	141	152	138	138
1928	10*s.* 6*d.*	87	10*s.* 0*d.*	111	140	152	140	134
1929	11*s.* 2*d.*	95	11*s.* 2*d.*	123	137	144	137	133

* 12-hour day: otherwise 8-hour. But see note 3.

† Calculated from Cost of Living Index based upon July 1914: 100. For precise comparison here the British figures from 1920 should be raised by 3 or 4 per cent. The table compares *trends* of real wages, not, of course, real wages.

‡ The exchange rate was more or less uniform for all years for which data are given.

[1] A leader which was probably a reflection of representative views may be found in *I.C.T.R.* Nov. 27, 1925. It approves of a recent exposition by Mr Goodenough, admitting that there would be a period of adverse trade while prices adapted themselves; but the price was justified since a gold standard was automatic, fool-proof and knave-proof.

[2] From 1920 based on data published by N.F.I.S.M.; the 1913 figure is calculated from sliding scales and the 1906 average. Weekly earnings are converted to shift earnings by dividing by $5\frac{1}{2}$. The actual number of shifts was rather lower (according to the monthly figures in the *Labour Gazette*), so that the average shift wage in the table is slightly too low—by 3*d.* at the outside.

[3] Based on data in *Eisenerzeugende Ind.* pp. 8–9, 51 (save for 1922, for which the figures are only a rough approximation). The published figures are specifically

Thus the German makers had for most of this period a far greater advantage than before the war in respect of the price of labour. Nevertheless real wages in the German industry were at the worst only a little more below the pre-war level than were the British wages, while after stabilisation and as a reflex of the overvaluation of sterling a considerable growth of real wages was possible, which was not paralleled in Britain, before the pre-war relation between the prices of British and German labour was restored.[1]

Re-equipment made necessary by war-time losses and devastation, and financed by the State, was the second factor which helped to sharpen Continental rivalry in these years. It was restricted to three centres of the industry, namely the Meurthe-et-Moselle district in France, the whole of Belgium, and Rhenish Westphalia; but within these centres—particularly in the first two—its influence affected not merely the operating costs of the steelworks but also the costs in the two chief auxiliary industries—transport and coal mining. The Rhine industry comes into the picture because though there was no destruction during the war there was a considerable compulsory destruction of munitions-plant subsequently, and because many firms lost important resources in Lorraine and most were forced to return to their former owners units of equipment brought in from the occupied territories during the war. On all these counts there was State compensation. Many Rhine firms also virtually lost resources by the placing of Luxemburg outside the German customs area; they sold out to French and Belgian interests, and had resources, therefore, to use at home, though no compensation.

Restoration gave an opportunity for improving, and there is no doubt that the productive efficiency of the devastated districts was considerably increased in the early post-war years. The French coal mines of the Nord, for example, were "electrified" and provided with more efficient and more extensive

for 300 shifts. These German insurance figures are stated officially to be rather high, since they take into account the incomes of many salaried officials and exclude some low-paid workers who are classed in the by-product industries. There was probably more overtime in Germany too. Cp. *ibid.* pp. 54, 160–1.

[1] Some other aspects of these figures are considered later.

coking plant; and the standard of railway equipment was raised.[1]

Only the changes in steel plants themselves, however, can be considered in any detail here. Of these it must be said at the outset that their significance has often been exaggerated. It is quite misleading to suppose—as some writers do—that any one of the districts concerned owed the modernity of its equipment mainly to this rebuilding, or that the plant in any one of them was "completely modernised" at its conclusion.

Confusion on this point was more justified in a superficial investigation as regards the French than the Belgian industry. But this was only because a surprising number of the French works which suffered in the war were either of recent origin (seven were completed since 1910)[2] or very recently modernised.[3] Hence while it would have been a godsend to the British industry to have many of its plants destroyed it was hardly so in France. In the period of rebuilding the majority of the French plants did not need any fundamental changes either of layout or equipment. Foundations, buildings, blast-furnace stacks, even blowing engines, were often left intact, while the best of the equipment—electric motors and cranes, gas engines, mills, the equipment of Thomas and Siemens shops and pits—had been taken to Germany. All this could be utilised again, and much of it was.[4] In a few instances old layouts and old-style steam-driven mills were abandoned;[5] and in a few others a higher degree of specialisation was introduced—a result of combination,

[1] E.g. *Rep. on Econ. Cond. in France*, 1934, pp. 115, 124 and 401 sqq.

[2] At Rehon, Chiers, Longwy-Bas, Louvroil, Wingles, Aulnoye, and Valenciennes.

[3] The Aciéries de Longwy had been very thoroughly reconstructed almost throughout, had installed electric drives for its heavy mills, and introduced three semi-continuous mills for light products. There is a useful history, issued privately (*Aciéries de Longwy*, 1880–1930). Micheville was completely reconstructing its Thomas plant in 1914.

[4] *R. de Métallurgie*, 1920 and 1921, includes a great deal of information on all this; and *Aciéries de Longwy* is useful for this works. Here three blast furnaces, one (of two) blooming mills, the heavy plate mill, Thomas and open-hearth shops, and three semi-continuous mills were reconstituted with very slight changes.

[5] At Joeuf, for example, the mills were almost completely changed (*R. de Métallurgie*, 1920, p. 580) and the Denain-Anzin Company completely changed its layout (*ibid.* 1920, p. 250).

but exceptional.[1] In most if not all, on the other hand, some pre-war equipment was retained—particularly for smelting—which was very noticeably not "the last word". Generally, of course, reconstruction allowed the incorporation of detailed improvements which economised materials and labour and increased capacity; but in theory, at all events, the costs of such changes were not borne by the State.[2]

There was probably more change in Belgium than in France, but the general effect was less modern than in France, and makers subsequently regretted not making more radical changes. The *doyen* of the Belgian industry, M. Trasenster of Ougrée-Marihaye, proposed that the chief firms should form a trust whose scale would permit the use of mass-production methods at all stages of production. But the interests were hard to reconcile, and since markets were to be regained it was decided that, haste seeming important, the old structure should be retained, and old buildings and plant which were available should be used as a nucleus in rebuilding. Some Americans counselled this on the ground that it was unwise to buy a lot of new plant when prices were high; perhaps they doubted where the credit would come from. Most Belgian firms modernised fully in some branches of production, but none appeared, or became in any reasonable sense, modern throughout.[3] Ougrée mechanised its iron-smelting department fully, from the unloading of ore and coal onwards; but did much less in the steelworks, of which parts were almost primitive as late as 1933, though there was a

[1] Homécourt and Micheville came virtually under one management in 1919; the former was specialised on plates and semi-products, the latter on rails and sections. Both were particularly severely damaged. Another instance of specialisation resulted from the acquiring of the Espérance and Pont-de-Vendin steelworks by the Aciéries du Nord et de l'Est. One was not rebuilt, one was specialised on light sections (using a pre-war semi-continuous installation), the other on heavy sections: *ibid.* 1921, p. 198; and R. du Fou, *op. cit.* p. 89.

[2] Certainly the cost of rebuilding and the amount of State compensation did not correspond. The financial position was sometimes misconceived; e.g. Sir W. Larke remarked that a Belgian firm had received £1·5 millions from the State towards the cost of a new plant costing £2·5. He omitted to remark that the firm had had a flourishing plant before the war, which had had a capital value but had been destroyed! (Balf. Comm. *Min. of Evid.* Q. 6227).

[3] This account owes much to information very kindly given in 1933 by M. Houbaer of Cockerill's.

Morgan strip mill. Cockerill's made their chief changes in the steelworks, building a new open-hearth plant which could be heated with coke-oven gas, and installing new blooming and section mills of American pattern and with electric drives, and a semi-continuous rod mill. Changes of this sort had been contemplated before the war, but the destruction of the old mills no doubt eased the transformation, and a real change of general layout occurred. There was much less change in the blast-furnace plant; the electrical generating station remained intact (though it was extended) and the old-style plate mills were unchanged.[1] None of the Belgian firms had a continuous billet or sheet bar mill even by the early 'thirties.

German State-subsidised reconstruction differed in character from the French and Belgian, inasmuch as it involved additions or modifications to existing working plant with the occasional erection of a wholly new unit, but not rebuilding from ruins. Yet the advance in efficiency in the German industry may well have been the greater; for the industry had had a continuous experience during the war, had the most highly-trained personnel, was stimulated by its new disadvantages, and possibly less hurried in its decisions.

In judging the competitive significance of subsidised reconstruction it is to be borne in mind that less new building was undertaken in Europe than in Britain during the war itself: certainly far less which pretended to be situated or designed for low-cost production. In France, apart from the completion of Thyssen's contemplated Thomas works at Caen, new works were for open-hearth steel and mostly in the Centre;[2] and in Germany shortages of labour and materials were so great as to forbid any building not essential for making special war equipment.[3] Plans for new Thomas plants were formulated, but

[1] There is an account of the changes at Cockerill's in the *R. de Métallurgie*, 1921, pp. 386–8; the account of Ougrée (pp. 620 *sqq.*) is less satisfactory. Both are by Trasenster, but he does not reveal his earlier ideal.

[2] For a short survey see *R. de Métallurgie*, 1921, pp. 14 sqq.

[3] Germany had no plan for mobilising the steel industry for war purposes. Steelworkers were called up as conscripts, and the Italian workers left for home. There was soon a shortage of munitions, and an agitation for new organisation. After some months the monopoly of the seven armaments firms was broken

appear to have got no further. The post-war Continental re-building appears to have balanced the account, preserving the gap between Continental and British technique which had existed before the war, but widening it only a little, if at all. Alongside the railway and mining improvements it no doubt did constitute a positive gain, but far less than was often implied. And it is impressive that much successful post-war competition came from plants outside the centres where subsidised reconstruction occurred. This competition came, moreover, from plants of very different character. In Luxemburg it came almost entirely from plants of recent origin, the two most important completed about 1912,[1] which were admirably efficient. In the Moselle (formerly German Lorraine) there were plants of very different ages: Hagondage was completed just before the war by Thyssen; Rombas dated back to 1900, and the Germans had planned a complete modernising in 1916–17, which was carried out in the late 'twenties;[2] de Wendel's Hayange plant dated back much further, and retained as late as 1933 features which were antiquated before 1900.[3] Finally, south of Nancy, there was the Neuves Maisons plant, laid down in 1900 and subsequently kept up to date by patchwork changes, but never so

through. Labour supplies were augmented by using Belgian and Russian prisoners, and by employing women for heavy manual work. Spanish and Swedish ore supplies were cut down; the entry of Rumania into the war created a shortage of lubricating oil, and the supply of scrap proved only moderately elastic. The Government were loath to use resources for new equipment and even for repairs, hence plant was brought in from works in the occupied territories. Some occupied plant not of direct use was used to swell scrap supplies. Nutzinger, *op. cit.* pp. 30 sqq. and Däbritz, *op. cit.* pp. 365 sqq.

[1] The Esch works of the Arbed Company, making light rods and sections, its mills skilfully adapting the continuous principle to the production of a varied programme; and the Belval works (in the Arbed group since 1925), which was put up by Gelsenkirchen, making rods, heavy sections, billets, and wire rod: here again continuous and semi-continuous mills had been installed in 1912.

[2] There is an account of Rombas in *Le Génie Civil*, 1930.

[3] The Bessemer shop had small converters and an inconvenient layout dating back to 1881. The blast furnaces had been modernised but were cramped; the heavy mills were all steam driven. The chief open-hearth shop of the firm, at Moyeuvre, was admirably equipped after the war, but it fed rolling mills which were (to quote a memoir privately circulated by the firm itself, dated 1927) "déjà anciennes", steam driven, unable to cope with heavy ingots and unable to cope with the whole ingot output of the melting shop. There were plans to change all this, and much of the de Wendel plant was modern.

radically reconstructed as Rombas.[1] The success of these plants —for all were profitable—suggests at once the heterogeneous sources of competitive strength and the fundamental importance of the cheap ores.

The third legacy of the war which discriminated in favour of the Continental steelmakers was analogous to the second, a projection of the policy of reconstruction, namely a permanent increase in the economic activity of their governments. This took many forms, and affected the steel industries at many points. In Belgium, for example, the Government greatly amplified the consular service and organised trade missions to promising export markets, apparently with some skill.[2] Steel-making was most directly affected everywhere by transport policies. In Germany, Belgium and France alike railway rates on steel exports were markedly low, more so than before the war; the preferences being most remarkable in France, where the need was presumably most urgent. Although most of the French railways were not owned by the State, the State was represented effectively on the rate-fixing body, and bore the cost of loans raised to meet deficits, which were common. As a result of the export preferences railway rates on exports from the Ruhr, Belgium and Lorraine appear to have been no higher in terms of sterling after than before the war. It cost 11*s.* to send a ton of steel bars 100 miles by rail to a home destination in Germany in 1930, 5*s.* 6*d.* to a port for export; the corresponding French rates were 10*s.* 6*d.* and 5*s.*, and the Belgian 7*s.* and 3*s.* 6*d.*[3] From the Saar to Antwerp it cost 7*s.* 9*d.* a ton in

[1] L. Bailly, *Défense des Actionnaires et Finance Minière* (Nancy, 1930), pp. 327 and 369–70, quoted the chairman and the managing director of Châtillon-Commentry, to whom Neuves Maisons belonged. This plant had not had "l'heureuse fortune d'être sinistré". Costs were not quite as low as in the "usines type Est" despite very heavy annual investments. The works was distinguished by the introduction of a special mode of heat-treating rails invented by its manager.

[2] *Rep. on Econ. Cond. in Belgium*, 1922, pp. 51 sqq.; 1923, p. 30. The Government had adopted the not very original watchword—"Import less, export more, produce more." Tariffs were raised, but this was not very vital for steel.

[3] F. Benham, *Iron and Steel Industries of Germany, France, Belgium, etc.* (London and Camb. Econ. Service, 1934), p. 49, gives a very useful table of comparative rates. The sterling figures given here are approximate only.

the years 1926–30; from Thionville 6*s*. 9*d*.; from Esch 5*s*. 8*d*.; from Longwy 4*s*. 9*d*.; from the Ruhr 5*s*.[1] French rates were also very favourable on the export of ore, which was of great importance for Belgian and Luxemburg competition. Amazingly low rates were charged for firms taking regular trainloads of 1000 tons carried in their own 40-ton wagons.[2] The rate from Briey to Liége was 5*s*. (sterling) a ton in 1933; less (in sterling) by about one-third in the late 'twenties.

Railway rates for internal traffic were not so favourably affected by post-war policies.[3] On the other hand, facilities for water transport were extended on a scale not commonly appreciated in Britain. The Belgian industry probably gained most from this, through the building of canals to take at first barges of 1300 tons and later 2000 tons, from both Charleroi and Liége to Antwerp, and to connect both these centres with the newly developed Campine coalfield and with Brussels. This system halved the cost of sending steel to Antwerp, bringing it down to 2*s*. or 2*s*. 6*d*. per ton.[4] The system was not fully in operation till late in the 'thirties. In France there were also notable developments of the State canal system in the 'twenties, but it was not till the end of the decade that a project intimately linked with the fortunes of steel was undertaken—the building of a canal from Metz to Thionville.[5] This was an old plan, first talked of in 1867; it cheapened coke freights to the Moselle works and freights on the Moselle deliveries north, whether for export or for internal distribution. The canal linked up with other parts of the French system. The rate to Antwerp fell by 20 per cent—from 12*s*. 6*d*. a ton to 10*s*. sterling a ton—for a works on the

[1] *Eisenerzeugende Ind.* pp. 104, 219.

[2] Nutzinger, *op. cit.* p. 83.

[3] E.g. in Germany rates on finished steel rose by 60 per cent or more for 15-ton lots over 250 miles or more, and rose more for lighter loads and shorter distances. Raw-material rates rose less: 40 per cent for scrap and coal, less for ore, on an average. *Rohstoffversorgung*, pp. 35 and 240; *Eisen- u. Stahlwaren Ind.* pp. 152–3; *Kohlenwirthschaft*, p. 235.

[4] *Eisenerzeugende Ind.* p. 233.

[5] *Rep. on Econ. Cond. in France*, 1934, pp. 423–9. Cp. also pp. 430 sqq. for the remarkable expenditure on port development in France—which no doubt constituted an important demand for steel, though reparation deliveries in kind were often turned to this use.

Orne in 1933.[1] But since this project had been only half-capitalised by the State, the steel firms providing the other half, a reduction in transport rates alone did not measure the value of the change; which in any case had no bearing on the events of the "black decade". In Germany the chief event in canal history for the steel industry was the building of the Mittellandkanal, stretching from Westphalia towards Berlin, and linking up by 1928 the Rhenish coal and steel with the cheap ores of the Harz. The prospective importance of this was apprehended in Germany in the 'twenties, but the ores were in fact little used.[2] There were other extensions and improvements of the canal system of more immediate significance, but cheapening internal distribution rather than production costs.[3]

Some of the improvements in transport facilities were not merely an outcome of the desire to reduce costs but also designed to lessen unemployment. In all the Continental countries these "public works" were in fact important stimuli of the home market demands for steel. They were not always thought of in these terms, but at some times this was their chief inspiration. It was markedly so in Germany in the early years of the restored mark. From 1925 to 1927, for example, loans exceeding 150 million marks were made on cheap terms to the Federal Railways to aid in the reconstruction of permanent way and bridges, the renovation of rolling stock, electrification near Berlin, and the completion of new lines projected before the war. These loans were regarded as an emergency measure to relieve unemployment. With the same object much smaller sums were given for hastening canal development.[4]

[1] In the late 'twenties the rail rate (50 francs) would have been about 8*s.* 4*d.* sterling. The works had a feeder to the Moselle canal system, and its own harbour.

[2] *Rohstoffversorgung*, pp. 45, 71 sqq. For later developments, cp. below, p. 465.

[3] Cp. the *Rep. on Econ. Cond. in Germany*, e.g. 1925–6, pp. 106–7, and 1932, pp. 145–6. Most of the development was financed by the State, much of it to reduce unemployment. Occasionally local interests were called in to contribute.

[4] There is an informative article in the *Labour Gazette*, March 1927, p. 97, which also deals with the (German) Special Export Credits scheme to aid trade with Russia, the Government guaranteeing 60 per cent of the sales price of goods sold. The banks were then ready to finance the trade, much of which was metallurgical. It is said that while steelmakers collectively denounced expenditure on public works individually they urged it upon local authorities.

Finally, the war helped Continental competitors because it gave rise to influences, apart from inflation, which widened the gap between the price of European and British labour.

It has been seen that the advent of the eight-hour day was likely to have this effect, since even if it were applied with equal rigour in Britain and Europe and raised labour cost in equal proportions in all centres, the high-wage centre was bound to be at a greater absolute disadvantage than hitherto. But the application was not quite equal in all centres; there was more latitude throughout the decade in France and Belgium than in Britain, due no doubt to the weaker position of the unions and the lower wage standards there: while in Germany they returned to the old system for two years (1924–5), the eight-hour day being thereafter slowly and never completely re-established.[1]

But this was not all.

In Germany the influence of inflation was so pervasive that it is hard to assess other forces. Nevertheless it is likely that two forces were important inasmuch as they lessened the impact of falling money- and real-wages on the quality of labour. There was the experience of the war blockade on the one hand, and on the other the relatively low level of food prices—illustrated above in Table XXXV—which was possibly in a measure a result of State policy.

The remarkable fall of German wages might well be expected to have led to a decline of efficiency. And there was in fact an astonishingly lower productivity per head in the early 'twenties—by pre-war standards—as the following table shows. (For subsequent comparison British figures are also included.)

Contemporaries certainly often regarded this fall as a result largely of the impairing of efficiency by under-nourishment. Yet there is good reason to doubt whether this is sound; for although the problem does not allow of precise statistical analysis there were undoubtedly a great number of other factors reducing production, while there are signs that the importance of under-nourishment at this time may be easily over-emphasised.

[1] *Eisenerzeugende Ind.* p. 160; *Rep. on Econ. Cond. in Belgium,* 1922, p. 91; Brelet, *op. cit.* p. 91.

To take the "other factors". There was, in the first place, a noticeable decline in average efficiency arising out of a shortage of experienced labour, which had two origins—on the one hand the shrinkage of the German production during the war and the toll of war on the workers in the industry, on the other the

Table XXXVI

Productivity of Labour (output per man in tons)

	Blast Furnaces		Steelworks			
			Germany			Great Britain
	Germany[1]	Great Britain[2]	Steel melting	Rolling	Melting and rolling	Melting and rolling[3]
1913	400	—	345	104	77	—
1920	192	—	—	56	—	48
1922	224	—	—	63	—	37
1924	240	281	290	80	60	49
1925	345	285	325	100	73	49
1926	370	—	480	122	92	—
1927	470	365	545	133	101	52
1928	590	348	500	123	93	52
1929	600	399	515	123	96	58

introduction of the three-shift system, which meant promotion for many "second-hands" and "third-hands" and the recruiting of new personnel. One set of statistics shows employment in the industry as 40 per cent more at the peak (in 1923) than before the war, and 12 per cent more in this year than in 1921.[4] Probably these figures exaggerate, but this was the trend. A surprisingly large percentage of the workers in the early 'twenties were between nineteen and twenty-five, and relatively few in 1926 had been more than five years with one

[1] *Eisenerzeugende Ind.* p. 8 and *Stat. B.I.S.F.* (for production).
[2] Numbers employed from Insurance Statistics.
[3] The output of rolled products includes finished iron and steel with the exception of galvanised sheets and tinplates and with the addition of the plate and sheet bar made at home and *sheet* bars imported.
[4] Bresciani-Turroni, *op. cit.* p. 199.

firm.[1] The problems which faced the German industry here must have faced British makers too, but less severely, because the British industry had expanded in the war, and the eight-hour day was introduced when demand was shrinking.

So much for the decline in the quality of labour. By its side there was a mass of factors, most of them not superficially obvious, also lessening the productivity of labour. One was, of course, very obvious. The character of the operations in iron and steel making is such that at most stages it is not possible for a man by working harder to do as much in eight hours as he formerly did in ten, so that the introduction of the three-shift system inevitably reduced productivity per head. The eight-hour day had another, obscure, effect: for in rolling mills and possibly Thomas steel shops minor repairs and roll changing had now to be done in working time which had hitherto been done in the long pauses customary in the two-shift system.[2] In blast-furnace working shortage of coke—accentuated by the Reparations deliveries—slowed down production,[3] and sometimes the steelworks were held up through want of iron. And throughout the German industry the character and distribution of orders tended in several ways to lessen productivity. More of the steel made was open-hearth steel—which required more labour than Thomas steel.[4] More of the rolled products were of small section, often highly finished, involving three stages of rolling—not merely two.[5] There was, too, less re-rolling of semi-products

[1] In one mill the percentages of the workers who were between 19 and 25 were 6·3 in 1913–14, 20 from 1921 to 1924, 5 in 1924–6; in another 4·5 in 1913, 30 from 1921 to 1924. 30 per cent of the workers in another mill had been less than five years with the firm in 1926; 37 per cent in another. The figure varied considerably, being lowest for isolated plants, highest for works in Rh. Westphalia, where there were plenty of chances of moving: *Arbeitsleistungen in Stahlwerken*, pp. 151, 189–91, and *passim*. The youthfulness of the workers might reflect the deliberate policy of employers: to have as large a proportion of low-paid "learners" as possible, and many unmarried men. Unions tried to check the abuse of young labour by forcing up "learners'" wages; and it is likely that there was little abuse in fact. No steelworks would aim at the rapid labour turnover implied by the second set of statistics. [2] *Ibid.* p. 206. [3] *Arbeitszeit in Hochofenbetrieb*, p. 19.

[4] 45·9 per cent of the German ingot output (post-war area) was of Thomas steel in 1913; 36 in 1920; 41·9 in 1924. The percentage continued to rise.

[5] 57 per cent of the German finished products (post-war area) involved re-rolling in 1913; 62 per cent in 1922; 64 per cent in 1924.

brought into the post-war German boundaries from Lorraine, Luxemburg and the Saar than there had been before the war. To take influences of a different kind, there was a universal tendency for the demand for higher qualities of steel to rise, which needed special care in manufacture—took longer to melt, reheat and roll, and produced more "wasters".[1] In the early 'twenties orders were on an average smaller than before the war, and roll changes therefore more frequent. The absence of Kartells, between 1919 and 1925, also probably led to more roll changing, for central selling agencies had tried to distribute orders so as to give good runs on the mills. Finally, the struggle for business drove makers to take orders for which their mills were not economically suited,[2] so that, for instance, one mill made sections so greatly varying in size that in 1921 its output oscillated between 45 tons and 200 tons a shift, its monthly product being sometimes above the best of 1913–14 though most often far below it.[3]

The indications which suggest that under-nourishment may have been at most a slight influence are, broadly, three. Great variations in output, such as the one just quoted, are not likely to be at all explained by impaired personal efficiency. The average level of real wages was lower in 1922 than in 1920, but productivity considerably higher.[4] And, finally, when productivity was least, absences through illness were proportionately fewer among steelworkers than in 1913–14; it is true, of course, that their financial reserves and insurance payments were also lower at the later date.[5]

[1] *Arbeitsleistungen in Stahlwerken*, p. 177.

[2] Vertical links with consumers might have this effect.

[3] *Arbeitsleistungen in Stahlwerken*, pp. 184 and 202 sqq. Bresciani-Turroni finds it difficult to understand how the demand for labour was elastic in this period while the supply of coal was inelastic (*op. cit.* p. 308). The problem disappears for the steel industry, and probably for other industries too, certainly for coal, once the mass of influences lessening productivity has been observed. This drop of productivity made a fall in real wages at any given level of employment inevitable—hence the fallacy of a theory which makes wage movements a result of inflation only. Inflation was doubtless an important influence in determining that there should be low wages and much employment rather than higher wages and much unemployment.

[4] Bresciani-Turroni, *op. cit.* p. 307.

[5] *Arbeitsleistungen in Stahlwerken*, pp. 58, 119, 153. The reduction in illness may have been an outcome of the 8-hour day; there was an increase of illness in 1924–5.

The contribution of war-time experiences to the easing of the situation was twofold. It probably increased skill in the household use of resources;[1] and it led to the changes in the distribution of wages between different groups of workers; the difference between wages of skilled and unskilled workers was very greatly narrowed—it had always been much less than in Britain—and the system of family allowances was introduced. These policies continued.[2] In the war, too, munition workers were given special rations through their works to sustain efficiency, and "heavy industry" continued to enjoy this favour during the inflation.[3] The contribution of Government policy to the relatively low level of food prices is obscure. Perhaps the low level was determined mainly by the currency conditions; prices of home-produced food—and most was home-produced—may have lagged behind the prices of products most sensitive to the foreign exchanges. But there was price control for a time, and later the State held stocks to check speculation; there were probably hidden subsidies in favourable rail rates for foodstuffs, and in other ways agricultural costs were lowered by intervention.[4]

The situation in France and Belgium was very different, and the dominating fact was that the war accentuated the dependence upon foreign labour. Many Germans in the Moselle district migrated within the new frontier of the Reich, and in the French territories occupied during the war some of the native workers had been killed in the war, and the native

[1] *Rep. on Econ. Cond. in Germany*, 1922, p. 63.

[2] *Ibid.* 1923, pp. 80, 104–5, 1924, p. 18.

[3] F. A. Schilling-Voss, *Die Sonderernährung der Rüstungsarbeiter, 1914–18;* for post-war supply of food cheaply by works, *Arbeitsleistungen in Stahlwerken*, p. 59.

[4] The treatment here is no more than provisional. The subject does not appear to have been carefully studied; but the contrast of British and German trends, with the British food price index *above* the general index, the German *below*, deserves explanation. It is interesting to remark that the trends in steel and in coal mining appear superficially to have coincided in Germany. There was the same rise in the numbers employed in mining after the war—partly due to the introduction of the three-shift system for workers above ground—so that in 1921 there were 46 per cent more miners in the Ruhr than in 1913, though the total output had fallen from 115 to 97 million tons. Productivity recovered in 1924 and by 1925 was at the pre-war standard; longer hours were being worked, the number employed fell off, and

population never recovered its pre-war density, and hence was less than ever a satisfactory recruiting ground for industrial labour supply. The gathering of foreign workers was expensive, particularly since many stayed a short time only; and the drawbacks resulting from frequent labour turnover were naturally greater than before the war. But the workers could be obtained for very low wages—the propensity to migrate from the east and south of Europe was perhaps increased by the devastation and political disruption due to the war, while America refused to absorb at the pre-war rate—and the employment of a personnel of mixed nationality, lacking a common language, must inevitably have lessened the chance of successful union organisation.[1]

Probably the labour in the minette districts was less efficient for some work than in Britain and Germany, but for reasons discussed earlier the disparity was certainly slight, save perhaps

money wages remained surprisingly low by English standards, real wages being just below 90 per cent of the pre-war level. Thereafter real wages rose fairly rapidly, but the advance of mechanisation kept labour costs stable. (Spethmann, *op. cit.* p. 206; *Kohlenwirthschaft*, pp. 62, 78 sqq. and 130.)

Wage Trends and Labour Cost (per ton) in Coal Mining

	1913	1925		1928	
	Labour cost	Real wages	Labour cost	Real wages	Labour cost
Germany (Ruhr)	6*s*.	90	7*s*. 6*d*.	100	7*s*. 6*d*.
Great Britain	7*s*.	94	12*s*. 6*d*.	86	9*s*. 6*d*.
		(1913: 100)			

(*Ibid. loc. cit.*; Bowley, *New Index Number for Wages*; *Reports of Ministry of Mines*.)

[1] For the whole of this topic Axel Sömme, *La Lorraine Métallurgique* (chs. XIII–XVIII), is admirable; though he tends, perhaps, to underestimate the importance of the Italian migrants. He argues that Italian migration was checked by the establishment of Fascism. At the outset, however, Fascism gave rise to a migration of high-grade workers, who have since occupied, in Belgium particularly, important jobs; and they have been all the keener at their work since they were anxious to remain. The Italians at Cockerill's had their own priest in 1933. In general, however, at that date the foreign workers in Lorraine were Poles, Russians, Jugo-Slavs, Czechs, etc., though the Italians were the first to arrive after the war. Until 1936 unionism was a negligible factor in the French industry. But in Germany the unions were powerful. The rise of wages after 1925 was a token of their constant pressure: in 1928–9 they obtained Government support for a claim for increased wages when trade was falling off. The prolonged discussions over this—punctuated by a strike—are of great political significance. Cp. *Labour Gazette*, 1928–9, *passim*.

in mining.[1] The advance of mechanisation minimised the need for great strength, and the feeding and manipulation of the furnaces and mills was, to casual observation, quite as orderly and expeditious as in Britain.

The statistics of French and Belgian wages are less ample than the German, and it is not possible to give a continuous series. But neither is it necessary to do so, for the situation was clear-cut and on the whole stable. The following table gives an adequate picture, German wages being included:

Table XXXVII

Wages of Iron and Steel Workers (per 48-hour week)[2]

	Early 1925[3]	Early 1930[4]
Great Britain	63*s*. 7*d*.	62*s*. 11*d*.
Germany	41*s*. 5*d*. (60 hr.)	50*s*. 11*d*.
France	33*s*. 11*d*.	37*s*.
Belgium	36*s*. 6*d*.	35*s*. 5*d*.

It may seem odd that, if such differences in the price of labour persisted, the chief British exports, galvanised sheets and tin plates, should be products in whose making labour costs were higher in relation to total costs than was common in most branches of the industry. But where it was difficult to obtain and retain labour it was natural to concentrate on expanding output in directions where this could be done by increasing capital equipment, so long as it remained profitable.

Thus the Continental makers had imposing new advantages; though it is to be remembered, first, that at the close of the decade the British makers had two subsidies through the de-

[1] According to information obtained by the author in 1933, newcomers to the mines, engaged in shovelling ore into trucks after it had been brought down by explosives, often did only half the work of the experienced men: 8 tons a shift instead of 16 tons or more. Since they were paid by the piece, only overhead costs and auxiliary labour costs were raised, not direct labour costs. Those who did not quickly improve were sent off.

[2] In iron-smelting, 56 hours. [3] Balf. Comm. *Min. of Evid.* I, p. 359.

[4] *Rep. of Delegation on the Conditions of the Iron and Steel Industries of Germany, France, Belgium, Luxemburg and Czechoslovakia*, 1929–30, XII.

rating act (three-quarters of their direct rate burden was removed, and the railway rates on their coking coal were reduced);[1] and second, that the Continental makers had serious new disadvantages to cope with owing to the territorial provisions of the Peace Treaty. These provisions separated the low-cost producing areas of Moselle and Luxemburg from the German commercial organisation which had hitherto handled their export trade and, prospectively, deprived them of their old home market;[2] the Moselle works became a new source of competition within France; and the German industry was deprived of the resources which were the basis of its cheapest production, many firms losing much of their newest equipment.[3] All the Continental centres were as a result afflicted with serious disequilibrium, which the process of reconstructing works accentuated; the situation was met by elaborate changes in the structure of the firms in all centres, and while these occurred price and output controls were impracticable. Everywhere the most prominent form of structural change resulting was vertical integration with consumers, whose motive in Germany (when it was not determined by currency conditions) was normally to secure home markets while firms were replacing sequestered equipment,[4] and in France and Luxemburg to do this also but in addition to facilitate the development of vast selling organisations with branches scattered at home and, more vital, abroad, whose expenses could more easily be borne if spread over a wide range of products, and whose work was simpler and more successful if they handled the range of goods often bought in composite orders.[5] Horizontal amalgamations were relatively

[1] The cumulative direct burden of local rates, per ton of finished steel, for one important firm just prior to derating was 3*s*. 6*d*. per ton; the firm expected to benefit from the reduction of railway rates by 1*s*. or 2*s*. a ton of steel. Obviously these figures would vary much from firm to firm. A neighbouring firm had a cumulation of burden of 1*s*. before the war, 6*s*. 8*d*. in 1927. *I.C.T.R.* Aug. 5, 1927, p. 320.

[2] There was a five-year grace period, with no tariff barrier.

[3] E.g. Thyssen's, Gelsenkirchen, Deutsch-Luxemburgische, Klöckner and Späters all lost steelworks; Bochum, Hörde and others lost mines. A picturesque cliché of the time—"nur ein Torso gewesen"—applied to two of every three of the great German firms: Tross, *op. cit. passim.*

[4] *Ibid.*

[5] *I.C.T.R.* Feb. 16, 1923, p. 226; *Rep. on Econ. Cond. in France*, 1923, p. 47; R. du Fou, *op. cit.* pp. 96–111..

uncommon,[1] but it was noteworthy that all save one of the important German works in Moselle and Luxemburg were bought by French syndicates in which old French steelmaking firms were influential, if not the controlling force.[2]

Kartells were re-established in Germany in 1925, after the restoration of tariff autonomy.[3] But to the end of the decade price-controlling associations were not established successfully in the minette centres, save for one or two products. This did not mean that a régime of unbridled price-cutting prevailed. Demand was growing, both at home and abroad, and it was possible usually to keep busy without recourse to such a policy. Moreover, the great strength of a small number of firms in France and Luxemburg, who were rivals at some points but partners at others, would have probably stood in the way of a prolonged demoralisation of the markets there. But whether on account of the activity of a few strong though relatively small firms, or of divisions between the great concerns which were allowed to remain so long as their effect was not destructive, price fixing remained competitive in form; occasionally there were spells of cutting; the gap between home and export prices was rarely wide; and of course the cost reduction which central selling offered, and which Moselle and Luxemburg had enjoyed before the war, was missed throughout the low-cost area of Continental production.

[1] In Germany there was one notable horizontal fusion, between Bochum, Gelsenkirchen and Deutsch-Luxemburgische; apart from this only small open-hearth plants were brought under common management. The chief French instances have been recorded above, p. 410.

[2] The "big eight" were Schneider's, de Wendel's, Marine et Homécourt, Pont-à-Mousson, Aciéries de Longwy, Nord et l'Est, Denain et Anzin, Châtillon-Commentry. The one independent firm bought Thyssen's Hagondage works; it was a syndicate of engineers, chiefly motor-car makers. R. du Fou, *op. cit.* p. 107. Diagrams showing the interconnexions of several French firms, though not the *scale* of participation, are given in Bailly, *op. cit. passim*.

[3] Integration led to a new stalemate, and once home inflation was over, and the franc-inflation had to be met, the exploitation of the home-market monopoly became more attractive than protracted internal competition. Nothing could be done effectively without tariff autonomy, but ingot-output quotas were adopted in 1924 (*Rep. on Econ. Cond. in Germany*, 1924–5, p. 133). The kartellisation of 1925 was more extensive than that of 1905–12, all products save sheets being covered: *Eisenerzeugende Ind.* p. 270.

Superficially the International Steelmakers' Agreement of 1926 belies the view that Kartells counted less in this decade than before the war, but its appearance is deceptive. Makers were all willing to enter associations on their own terms; not all were willing to make concessions. The German makers determined to use the restoration of their tariff autonomy as a means of inducing their neighbours to enter an agreement which would raise world prices, then particularly depressed owing to the franc depreciation. Firms in Moselle, Luxemburg and the Saar were offered a proportion of the German home trade on favourable conditions, but only if the French, Belgian, Luxemburg and Saar makers would accept a scheme for limiting their steel production, such limitation promising a rise in prices. The German plan was adopted, its sponsors accepting what they regarded as an unfairly low quota of the total steel output of the group in order to procure the adoption.[1] But the results of the scheme, which, in the spirit of modern diplomatic instruments, allowed straightforward price competition within the framework of association, were disappointing. Prices did not rise to the extent that had been hoped. From 1927 modifications were introduced at the instance of the Germans;[2] by 1930, when prices were breaking seriously at the onset of the Great Depression, the quota-agreement was merely nominal.[3] Throughout its course the gap between German home prices and "world" prices had ranged above 30*s*. a ton.[4]

Hence it was quite misleading to regard the "black decade" as a period in which all was plain sailing for the Continental makers. If the supply of capital was relatively plentiful and

[1] The fullest account of the negotiations and description of the agreement is given by Nattan-Larrier, *La Production Sidérurgique de l'Europe Continentale et l'Entente Internationale de l'Acier* (1929), pp. 281 sqq. The procedure was to forecast output for the forthcoming quarter, taking account of market conditions; the various producing groups were then allocated quotas of this output on a pre-arranged basis, whereby the Belgian and French quotas fell as total output rose, and the German quota rose. Each maker paid $1 per ton of quota to the executive; centres which made in excess paid $4 fine per ton of excess, centres producing below their quota received $2 per ton of deficiency. Surplus funds were periodically distributed in proportion to output.

[2] *Ibid.* pp. 308–10. [3] R. du Fou, *op. cit.* p. 128. [4] Below, p. 427.

capital burdens weighed lightly upon them, they had nevertheless special calls for heavy capital expenditure; the quickly changing situation tempted or even forced them to take short-sighted steps which raised costs or hindered their lowering; while the destruction of equilibrium prevented the rapid accumulation of reserves and added to the loan burdens of firms where it did not involve losses. In spite of all this it might fairly be suggested that the difficulties of the Continental makers were stimulating, those of the British makers paralysing.

3. PROTECTION VERSUS RATIONALISATION

If, then, there was a case for protection in 1903, there was a still stronger one in the 'twenties as a result of these new Continental advantages, whose mainly transitory character disposed politicians to inaction though it was rather an additional ground for interference. But the case against protection was strengthened as well as the case for it, because the difference between prices of Continental and British steel widened, and the danger of jeopardising consumers grew. A transitional period during which steel prices were very high, while the steel industry was reconstructed on the lines laid down by the Committee of 1917–18, could hardly be imposed on steel users whose difficulties in the 'twenties were already disturbing enough. Radical change in the industry on such terms might be too costly. And was there any guarantee that, given a tariff, the industry would make the adjustments needed to bring costs down to the Continental level?

The severity of the problem may be observed most simply by an analysis of price movements, which are represented in Table XXXVIII.

It will be remarked at once that the contrasts in 1913 and after the war were substantially the same in character, having regard to the shift of frontiers, but differed in degree; that the French and Belgian home and export prices were never very far apart after 1923; that the relative position of the German industry changed radically after the stabilisation of the mark;

Table XXXVIII

Prices, 1921–31 (gold prices, in shillings)*

	Steel Bars				Steel Plates					Rails		Tin plates	Tinplate bars
	G.B. delivered[1]	F.O.B. Antwerp[2]	France home, at works	Germany home, at Oberhausen[3]	G.B. realised price, at works	F.O.B. Antwerp	Belgium home, at works	France home, at works	Germany home, F.O.T. Essen	Germany delivered	G.B. delivered	G.B. F.O.B.[4]	G.B. F.O.T.
1913	143	117	150	109	143	125	—	—	120	123		262	104[5]
1921	213	147	198	120	323	215	215	—	135	—	—	—	—
1922	162	136	169	119	164	143	143	—	133	—	—	—	—
1923	200	152	169	168	171	157	163	154	190	—	—	—	—
1924	185	127	126	128	173	139	142	152	143	143	171	—	—
1925	170	113	115	132	170	135	130	135	145	144	164	415	140
1926	165	103	111	134	154	114	111	115	146	141	165	435	121
1927	166	97	99	134	156	122	128	120	153	144	167	382	119
1928	156	115	113	140	158	127	128	127	161	148	160	363	113
1929	160	116	122	141	159	126	128	130	165	152	160	367	120
1930	156	95	107	135	158	115	116	128	149	156	160	352	118
1931	130	72	85	128	157	82	76	115	151	156	157	285	93

* See note on p. 428.

[1] Transport cost may be roughly estimated at 10*s.* per ton.
[2] Transport cost from Belgian works was about 2*s.* 6*d.* per ton, German 5*s.*, French 6*s.* or more.
[3] Quotations F.O.T. Neunkirchen (Saar) were 6 M. lower.
[4] Prices are normally quoted for "boxes" of 108 lb.: this price "per ton" is for 20 boxes.
[5] Quoted, delivered price: *Stat. B.I.S.F.*

and, finally, that tinplate prices remained much more above pre-war prices through the 'twenties than the other prices quoted.

Beyond this point analysis becomes more complex. In so far as Continental and British products dealt with in the table—steel in general, and bars and plates in particular—were substitutes, the outstanding fact is the broad gap, never much less than 30*s*. a ton, between both home and average[1] prices obtained for bars and plates by French and Belgian makers on the one hand and by the British on the other. For tinplate bars the gap was less.[2] Home prices in Germany after the mark stabilisation were far closer to the British for all products than

* *Note on Table XXXVIII*. The British plate and tinplate-bar prices are derived from the sliding scale ascertainments; the German rail prices from the *Railway Statistics* (above, p.115). The rest are quoted prices; if they are inaccurate it may be assumed they are too high, not too low. Tinplate prices from *Stat. B.I.S.F.*; the remaining series mainly from *Stahl u. Eisen*, *Eisenerzeugende Ind.* pp. 104–5, *Eisen- u. Stahlwaren Ind.* pp. 126–8, supplemented by the *Bulletins* of the Comité des Forges, *I.C.T.R.* etc. Conversions and averaging are not always easy, and absolute accuracy is not claimed.

For the present purpose gold prices are convenient, but for some purposes the following unconverted prices will be more useful:

	British plates Realised Sh.	Belgian bars F.O.B. Antwerp F.	French bars F.O.T. East F.	German bars F.O.T. Oberhaus M.
1921, Jan. 1	435	650	650	2,450
July 1	290	400	390	1,750
1922, Jan. 1	197	430	475	5,030
July 1	177	415	445	11,470
1923 (aver.)	172	470	—	220,000
1924 (aver.)	189	650	587	128
1925	182	570	—	133
1926	154	770	828	134
1927	156	845	599	134
1928	158	1014	683	140
1929	159	1032	743	145
1930	158	872	639	135
1931	157	—	510	128

[1] The export price F.O.T. may be judged by subtracting transport cost from the Antwerp quotations; the average realised price was approximately half-way between the home and export price F.O.T.; rather above than below.

[2] British tinplate-bar prices appear in the table without parallel Continental figures; they may be compared with the French prices for merchant bars (a more finished product), which they frequently exceeded, and which were normally above the French home price for tinplate bars.

home prices in the franc-countries.[1] German export prices were naturally in line with the Antwerp quotations, so too were home prices when subject to A.V.I. export rebates; hence the average German prices were always markedly below the British, the difference rarely being as small as 15*s.* and usually much more.[2]

But of course the Continental and British products were not pure substitutes. All the Continental prices, including those for plates, were quoted for Thomas steel goods. British steel, save where it was a Continental semi-product re-rolled in Britain, was made by the open-hearth process. For a number of purposes Thomas steel was as good as open-hearth; for some purposes—for mild-steel tube strip and wire rod, and certain grades of sheet bar—probably better. The precise range over which the two types of steel were substitutes is in dispute; it was wider than the British makers, who were not unprejudiced, admitted.[3] Within it the comparison of prices afforded by Table XXXVIII is valid. But when open-hearth steel was required a considerable adjustment must be made. Continental quotations for open-hearth steel made to fairly rigid specifications were probably from 12*s.* to 15*s.* a ton above the Thomas prices which have been tabulated.[4] Thus the difference between

[1] The rail prices are a useful check; with transport cost deducted they are closely in line with German bar prices. Joist prices were considerably lower.

[2] J. W. Reichert, *Stahl u. Eisen*, May 12, 1927, pp. 787 sqq., gives useful data. The average home price obtained for bars by the Stahlwerksverband in its first year (1925–6) was 127·5 M., the average export price 108·6 M. (The home price quoted was 134 M.; "Antwerp F.O.B." fell from 113 to 103.) For girders one firm averaged 126·4 M. on home sales in 1925 when the quotation was 131·4 M.; the export price averaged 110·7. For plates the firm realised 139 M. at home in 1925 (145 M. quoted) and 130 M. for export. In 1926 the figures were much lower: another firm averaged 121 M. over all sales. For all products the home average tended to fall in relation to the quoted price in 1926 through the operation of the A.V.I. system.

[3] For an English discussion at the end of the decade, *J.I.S. Inst.* 1931, pp. 182 sqq.

[4] The difference between Thomas and open-hearth prices in Germany was raised from 5 M. to 8 M. a ton in 1925 to shift demand. It fell to 6 M. in 1931. But since extras were also charged in Germany (and on the Continent in general) where none were charged in England, e.g. for tests implying a guarantee, for small quantities, allowance must be made for this. A German official inquiry showed that "extras" had risen more than base prices since 1913. But the average "extra" on base prices, on all accounts—and there were extras in England on *some* accounts—was 5 M. to 6 M. per ton in the late 'twenties. Hence an allowance of 15*s.* a ton is probably too high. The difference between French and Belgian Thomas

British and French home prices for *identical* products ranged round 15*s.* a ton; German home prices (without rebates) were rather above the British for plates after 1925,[1] for bars in 1928–9, and for rails after 1928, but *average* realised prices were much lower, save for plates in 1928–9.

In this situation the Continental firms had a far better financial record than the British. In the late 'twenties German, French, Belgian and Luxemburg firms alike were able to put aside large sums of money for reinvestment, to pay their fixed-interest charges and to pay out small dividends on ordinary shares. British firms normally put little aside for depreciation, could rarely pay their fixed-interest dividends, and the ordinary shareholders in heavy steel companies got nothing.[2] Hence it may be inferred that at the rates of output worked in the late 'twenties, and having regard to the conditions of home competition and the markets for by-products, British costs were far above those in competing centres, particularly in the minette and its satellite areas.

This is compatible with the claim that the best British works —a very select company—could have worked at costs close to good Continental records. "We have never had a good run off this new equipment", Sir William Larke explained to the Balfour Committee.[3] The costs of these plants, whose owners were unable or unwilling to challenge the rest of the industry,

and open-hearth steels were not commonly quoted in series used here till 1931. In 1925 the difference was below 10*s.* in France. Early in 1931 in France it was 50 francs—about 8*s.*—for plates; but twice as much for wire rod and universal strip. By the end of the year it had risen to over £1; but this was due to the falling off in the market for Thomas steel, which was particularly acute. The difference in prices was apparently less stable in the franc countries than in Germany: lowest when demand for Thomas steel was good, probably. *Eisenerzeugende Ind.* pp. 96, 110, 260.

[1] This was the view of a German official inquiry: *ibid.* pp. 110–11.

[2] Fixed-interest charges were admittedly far heavier for British than for French firms, but this was almost certainly offset, in this context, by the volume of French re-investment; in Germany fixed-interest burdens rose as high as in Britain by the close of the decade.

[3] Balf. Comm. *Min. of Evid.*, Q. 6200. It is doubtful if the claim to work close to Continental levels could have been substantiated for any *whole* works save the best in Lincolnshire; otherwise the claim could only be made for single stages of production.

were clearly not price determinants; the significance of this will be considered later.[1]

Here in these figures was the substantial case against tariffs. It was rarely put this way, no doubt wisely, though also because the data were not often compared. But the broad facts were well known. They were brought into striking relief in 1925 by a conflict within the industry, for when the National Federation was asking the Government to set up a Safeguarding Committee some big steelmaking firms opposed the proposal, since as re-rollers for export markets they thought it vital for them to obtain cheap foreign steel.[2]

The table suggests not only that the gap between British and Continental costs was formidable, but that it showed no tendency to diminish. Checked by other sources of information this conclusion appears sound. British makers said constantly that they were improving their equipment. So many of them were; but the kind of changes they made did not check the relative deterioration. For the changes were predominantly small in scale, and could not give scope for the major economies

[1] Some other aspects of the argument from price to costs deserve comment. It may be suggested that the minette-area open-hearth steel would have cost more to make if more of it were made from pig iron, less from scrap from the Thomas process. But there cannot be much in this, as the 15*s*. margin allowed in the argument is wide. If the ores are difficult to use for open-hearth steel, as some say, the duplex-process can be used, as it will be at Ebbw Vale—steel can be half-cooked in a converter, and finished quickly in the open hearth. It may also be asked why the gap between British and Continental tinplate-bar prices was narrower than the gap between plate prices; and why tinplate bars were so much cheaper in Britain than plates. To take the second point first, plate making not only involved much more rolling, and more expensive handling and shearing, but there was more loss in scrap; roughly 21·5 cwt. of steel ingot were needed for a ton of tinplate bars, nearer 30 cwt. for a ton of plate. The relation of the British prices is thus comprehensible, though it is of course possible that the tinplate bar price was a less remunerative one than the plate one: there is no published information on this. Certainly it had to be more competitive, since the premium paid in Britain for open-hearth quality was probably particularly low for this product, and the market was well placed for Continental imports.

[2] *I.C.T.R.* June 26, 1925, p. 1058, refers in a leader to this "awkward fact". Probably Richard Thomas, among others, took this line; at their annual meeting their Chairman emphasised that since English tinplate prices were cut, foreign schemes for new works had been suspended, and he stated that in some form or another 75 per cent of British steel had to be exported—an exaggeration: *I.C.T.R.* Dec. 25, 1925, p. 1078.

enjoyed by rivals even before the war, but more extensively since.

In common-grade steelmaking no new plants were started in this decade,[1] and only three large-scale reconstructions undertaken. In 1923 Consett decided to use the vast liquid resources, which almost alone among the big firms it had harboured, on rebuilding its steelworks and mills, choosing to do so on the old site, whose original advantages had vanished as the local coal and ore had been exhausted. An alternative site on the Tyne, with Newcastle as a market for its coke-oven gas, had been rejected. The other two major transformations followed Continental models of fuel economy. Lysaght's Normanby Park works became the first in Britain to use no fuel or power from outside save coal for the coke ovens; and in rebuilding its Irlam plant (formerly the Partington Steelworks) the Lancashire Steel Corporation worked on similar lines with impressive results. Both these plants, it will be observed, had been erected since 1910,[2] while only the second of these three major changes advanced the strength of the low-cost locations. The elimination of plants was as uncommon in the decade as radical transformation, so that the structure pattern of the industry remained from this aspect very much as it was in 1900, though the average size of plants had grown. The contrast between the British and French industries in this matter is shown in the table on p. 433.

With Germany the contrast was of course more striking: over half the German make in 1929 came from eight plants whose individual outputs all exceeded 800,000 tons and averaged well over a million.

Plant improvement in Britain thus necessarily took place within narrow limits, though within those limits a good deal was done. Some of it extended the functions of plants: carried

[1] Several enterprises initiated during the war and just after only came to fruition in this decade. In high-grade steelmaking Firth's put down an extremely important plant for the manufacture of stainless steel sheets; but apart from this, though the work done on alloy steels was unmatched in any other centre of the industry save Germany, changes in equipment were on a relatively small scale. Electric furnaces, to take the simplest criterion, came in slowly.

[2] Their reconstructions were started late in the 'twenties. Irlam, having many finishing mills, could only be as self-contained as Normanby Park if it used no scrap.

Table XXXIX

The Scale of Plants in Britain and France
(000 tons of ingots)

Plants producing:	over 600	500 to 600	400 to 500	300 to 400	250 to 300	200 to 250	150 to 200	100 to 150	50 to 100	under 50
France[1] 1929	3	2	6	2	5	—	—	2	—	—
1913*	*3*	—	—	*6*	*1*	*1*	*2*	*2*	—	—
Britain[2] 1929	—	—	3	2	3	5	14	15	9	5
1900	—	—	—	—	*2*	*2*	*5*	*8*	*22*	*21*

* Post-war area.

by-product recovery further, for example, and added new finishing or fabricating equipment. Much was concerned with fuel economy: gas combustion was improved in open-hearth furnaces, and waste-heat boilers were added; better methods of gas cleaning were installed; water-tube replaced Lancashire boilers, electric motors displaced steam engines for rolling mills, and steam turbines reciprocating engines for blowing; recording instruments were occasionally put in to measure gas consumptions and so facilitate control; a few firms erected gasometers. Often such changes occurred because old equipment was worn out. It was astonishing that some of the changes had still to come,[3] while others improved on practices which had better perhaps have been wholly scrapped.

[1] These are based on published information, and the firms concerned made 80 per cent of the total French make of ingots in 1929. The pre-war giants were in German Lorraine; expansion of output after the war had been mainly in the French area; the figures for 1913 cover almost 75 per cent of output.

[2] These figures embrace all the makers of steel ingots for rolling save the highly specialised Sheffield firms. Some firms published their outputs; the others are estimated from districts' ingot outputs and data concerning melting capacity. The five most productive plants in 1929 were probably Colvilles (Dalzell), Steel, Peech and Tozer, Appleby, John Summers (Chester), and Bolckow Vaughan's (who *just* made 300,000 tons of ingots). Figures for 1913 would have much more closely approximated to those of 1929 than to those of 1900 (which included the Sheffield firms); average output had risen by over 50 per cent since 1900, but the distribution of output was not greatly changed (above, p. 195).

[3] E.g. the installation of mud-guns at blast furnaces, even on the North-East Coast. In one instance, after this change—which cost £400—the furnace could be "blown" for 8½ hours longer per week as a result, its output being increased thereby by 60 tons, and the number of tuyeres used was reduced by three per week.

All this had, cumulatively, an appreciable influence; but comparative statistics—admittedly treacherous material—show that the British industry at best barely held its place, and in some directions lost new ground. The figures tabulated above[1] with regard to labour productivity are an instance of the latter; a comparison with Belgian records gives the same result, though less impressively.[2] Data on fuel consumption suggest no new relative decline, but are impressive on account of the absolute contrasts they present. In Great Britain coke consumption fell from 28·4 cwt. per ton of pig iron in 1920 (approximately the 1913 figure) to 25 cwt. in 1929.[3] German coke consumption was 21·6 cwt. in 1924, 19·6 cwt. in 1929, a result the more striking since the amount of scrap charge fell much and the proportion of low-grade ores rose.[4] In Belgium and Lorraine, where all the ore was low-grade, the consumption was 21 cwt. in the late 'twenties; it had been higher before the war.[5] British practice improved, but it had not reached the best pre-war Continental level. Beyond the smelting stage the ground is less secure. The Federation has published data since 1920 on the consumption of coal in the post-smelting processes carried on by its affiliated firms, which show a noteworthy reduction throughout the decade, from 1·55 tons per ton of finished product in 1920 to 1·36 in 1925 and 1·13 in 1929.[6] But the figures may flatter the steelmakers, and the decline shown by these figures was

[1] P. 417.

[2] Here is a comparison with changes in Belgium:

Labour Productivity (tons per man per year)

	Blast furnaces		Steelmelting and rolling	
	British	Belgian	British	Belgian
1923	285	470	45	—
1925	320	430	49	66
1929	345	540	58	98

The rates of change are more reliable for comparison than the absolute quantities. The Belgian figures come from *Stat. B.I.S.F.* and L. of N. *Memo.*

[3] Based on information in *Stat. B.I.S.F.* The drop was partly due to the discarding of inefficient furnaces.

[4] *Eisenerzeugende Ind.* p. 13.

[5] Sömme, *op. cit.* p. 90.

[6] From data in *Stat. B.I.S.F.*

certainly not wholly due to more skilful use of fuel or the more common use of blast-furnace or coke-oven gas.[1] On the other hand the figures do not tell the whole story. For between 1924 and 1930 there was a considerable increase in the net sales of gas and electrical power by iron and steelworks,[2] an economy not accounted for in the Federation's figures. International comparisons in this field are treacherous, but the contrast between the Continental and British records is too striking to neglect. The Belgian figures are the most simply compared. They show an impressive fall over the decade, but they are chiefly remarkable for smallness. In 1929 the average consumption per ton of finished product was 4·9 cwt., against the British average of 22·5 cwt. For combined works it was 3·2 cwt.[3] For a number of reasons the Belgian figure was likely to be below the British, given equal economy, but not to this degree; and information for particular plants suggests that the British figure was not dominated by the consumption of unintegrated re-rolling and finishing processes, but that even big combined works using the hot-metal process and making mainly heavy products —plates, girders, rails and semis—had quite high averages.[4]

There was little disposition within the industry to deny the direct implications of all these figures. But they were treated as an outcome of the unequal conditions of international competition. They showed, after all, some zeal for improvement at a

[1] In 1920 very few semis were imported, and almost all the finished steel product had been melted and put through all its rolling processes in England, not merely re-rolled like much in 1925 and 1929; there was, too, a great falling off after 1920 in malleable-iron making, which is greedy of fuel, and, finally, there was an abnormally big proportion of heavy steel goods in the product of 1929.

[2] This is traced in the *Census of Production*, 1930, Part II, pp. 32, 45, 48. The quantity of electricity sold rose from 114 million units in 1924 to 391 in 1930. In the latter year 282 million units were purchased; there are no data on this for 1924. Gas sales rose in value from £216,000 to £461,000.

[3] Calculated from *Stat. B.I.S.F.* No data are available concerning sales or purchases of gas and electrical power. Sales were appreciable; purchases may have been.

[4] In one important instance the figure was 15 cwt. per ton of finished steel. There were no doubt better records, but probably they were rare. In Germany, the unchallenged leader in fuel economy in these years, consumption was certainly lower than in Belgium, but comprehensive figures appear to be lacking.

time when resources were lacking. The annual expenditure on capital account[1] in the British industry was admittedly low—all told, it amounted to between one and two million pounds a year, in the late 'twenties,[2] some of this for the coal mines of integrated firms. A mere 1 or 2 per cent of the valuation of the whole plant in the industry, but the reserves and income of firms could hardly support more, and it was out of the question to add still further to fixed-interest indebtedness. Given a tariff, greater expenditure would become possible.

It would. But to what use would the opportunity be put? It was commonly feared that protection would not result in the radical change vital if costs were to be brought down throughout the industry to Continental levels. Instead, prices would rise and the high-cost producers be saved. "Firms which should disappear would continue."[3] Hence, even if a tariff were vital so long as Continental makers dumped, "rationalisation" must come first.

This view was influentially sponsored in London, and it achieved its most authoritative expression in a report made after prolonged inquiry by a sub-committee of the Committee of Civil Research in the autumn of 1930.[4] This body, presided over by Lord Sankey and including Sir William Plender, the accountant,[5] judged the smelting and coke-making branches of the industry wholly antiquated and inadequate; ore mining and steelmaking less so,[6] but still in need of great expenditure. All told, £15 millions at least, and probably much more, would be needed to restore the technical efficiency of the industry.[7] Prior

[1] Other than expenditure on capital equipment with a relatively short life, e.g. for furnace linings, etc.

[2] Based on authoritative information.

[3] *Ironmonger*, Nov. 29, 1930, p. 68.

[4] The report was confidential, but became available in Germany. Summaries in German newspapers were translated and published in England. The version used here was published in *Ironmonger*, Nov. 29, 1930, pp. 67–8. The accuracy of the record has never been questioned.

[5] The Committee, appointed in August 1929, included, apart from those named in the text, Mr Shaw, Minister of War, C. T. Cramp, Secretary of the N.U.R., and Sir C. Budd: *Labour Gazette*, Aug. 1929, p. 272.

[6] "Only a comparatively few (steel) plants were entirely out of date."

[7] Twenty new blast furnaces, to make 400 tons per day each, would cost £8 millions; 160 furnaces could be modernised for £5 millions. Five new coking plants,

to rebuilding there must be regional amalgamations to establish unitary control in each of the main producing districts.[1] The revival of the Bessemer process, for which "there is no technical objection in certain areas", was to be provided for. And probably—though the published summary does not say as much—this implied also some recognition of the need for locational change, which had been advocated by witnesses concerned with the early stages of the greatest post-war enterprise in British steelmaking, the initiation of steelmaking in Northamptonshire—by the re-rollers, Stewarts and Lloyds'.[2] The Committee believed there need be no difficulty in obtaining the capital required, for it had consulted the Governor of the Bank of England, and he had "declared himself to be of the opinion that the necessary money for the reorganisation could doubtless be found, provided the proposals were technically and financially rational".[3] When the British industry had "renewed its youth" it would be able, the Report held, to match Continental costs; but dumping might still make it unprofitable. If this occurred, and "reconstruction miscarried" after some experience over at least part of the field, then protection might be invoked. "The immediate application of Safeguarding would rather defer reorganisation....It would be dangerous to let the reorganisation wait."

Put quite bluntly, the policy advocated here was that the industry should be forced to reconstruction by extensive bank-

urgently needed, to make 2·5 million tons of coke would cost £4 millions. Ore mining needed the expenditure of at least £1 million. No estimates for expenditure on steelworks appear.

[1] Particular emphasis was laid on the need for fusion on the North-East Coast.

[2] Stewarts and Lloyds' first thought of making steel in Lincolnshire, where they bought an ironworks but could not obtain ore fields. The Corby ore fields came to them in 1920 when they bought Hickman's steelworks at Bilston, which already supplied them with steel for their Midland works. It was not till some time later that the potentialities of the ores were appreciated. The firm made steel in Scotland as well as in Staffordshire, but used so much imported strip that it may rightly be dubbed a re-rolling firm in this context.

[3] The Committee made it clear that it did not think "the promise of new funds already received from financial circles would fulfil all the requirements of the industry"; this had no bearing on Mr Montagu Norman's declaration, and merely meant that the Committee regarded the reconstruction schemes which were being hatched as inadequate.

ruptcy, which would allow reform to be imposed by financial groups. This probably implied both that firms would not voluntarily enter into mergers, being anxious to retain their individuality or unconvinced of the advantages of combination, and that large firms were unlikely to drive out small ones without discrimination in banking policy, save after great and prolonged expense.[1]

On the first point a considerable amount of experience had accumulated; and it was probably true that the amalgamations of the last few years had only occurred because of the serious indebtedness of one or more of the parties, which had allowed the exercise of pressure. In the late 'twenties the financial difficulties of many firms grew overwhelming; heavy bank overdrafts piled up alongside the other fixed-interest burdens, and financial reconstruction became imperative, forced on firms by their creditors. Sometimes it merely took the form of a scaling-down of the nominal values (and sometimes the interest rates) of debentures, preference shares and ordinary shares, together perhaps with a transfer of part of the equity to the fixed-interest security holders, which was of course the only real loss incurred by ordinary shareholders.[2] Misjudgments of the early post-war period were thus "liquidated", and the effects of deflation offset; and ordinary shareholders were often perhaps lucky not to lose all. In many instances reconstruction was associated with the dismemberment of elaborate vertical combinations and with the creation of new horizontal consolidations. For example, the badly conceived heterogeneous integrations of three great armament firms—Vickers', Armstrong's and Cammell Laird's—were broken up, and their high-grade heavy-steel components were formed into the English Steel Corporation.[3] Armstrong's interests in common-grade steel were also consolidated and

[1] *Rep. Macmillan Committee*, pp. 165–6.

[2] Mere financial reconstructions were rare. Often an apparently mere reconstruction really paved the way for something else.

[3] *Econ.* Dec. 22, 1928. Vickers-Armstrong's was formed to build warships; Cammell Laird's became solely a shipbuilding company; the railway wagon interests of Vickers' and Cammell's were united, the electrical business of Vickers' became an independent unit.

merged with those of another firm, to produce the Lancashire Steel Corporation.[1] On the North-East Coast Dorman Long's absorbed Bolckow Vaughan's, whose capitalisation was greatly reduced in the process.[2] On the Clyde Colville's absorbed Dunlop's, who were able thereby to compound with their creditors.[3] In South Wales Guest Keen's and Baldwin's merged their heavy-steel interests early in 1930.[4]

In all these instances creditors, particularly bankers, had been concerned in the negotiations, and in many if not in all had had a determining influence. Thus Barclays had refused to renew Bolckow's overdraft of £1 million unless the merger with Dorman's was completed.[5] In Lancashire the Bank of England, commercial banker to Armstrong Whitworth's, whose collapse was the most disastrous of all those in the steel industry, held the mastery; the existence of both the English and the Lancashire Steel Corporation depended upon the participation of the Bank, and before it took action it had an expert survey made of the British steel industry, sponsoring only such reconstruction as seemed to it adjusted to the healthy development of the whole.[6] The plan which it accepted was singularly like that advocated by the Sankey Committee and visualised its regional consolidations, with each main region specialised in a few products only: Lancashire on wire in particular, Scotland on steel for ships. Where bank influence was slighter, plans for amalgamation appear to have hung fire. There were negotiations in 1930 between Cargo Fleet and Dorman's, the intermixture of whose plants on Teeside to all appearances made consolidation desirable;

[1] *Ibid.* Nov. 22, 1930, p. 969.

[2] *I.C.T.R.* Nov. 15, 1929, p. 776, gives the financial details.

[3] *Econ.* Dec. 6, 1930. Dunlop's had £107,000 of preference share interest outstanding, and had borrowed £335,000 from Lithgow's, who now agreed to forgo a small part of the loan, and to forgo interest on the remainder till 1933.

[4] *Econ.* Jan. 11, 1930.

[5] *I.C.T.R.* Nov. 1, 1929.

[6] A law case arising out of the reconstruction of Armstrong's elicited the precise statement that the whole scheme depended upon the Bank of England being willing to give up all rights with regard to £3 millions of debentures and to take ordinary shares. The Bank was behind the syndicate organised by Schröder's to establish the Lancashire Steel Corporation: *Econ.* Feb. 16, 1929, p. 347; *I.C.T.R.* March 22, 1929.

but the thing languished.[1] In Scotland in 1929 all the makers took part in discussions of what was known as the "Weir Scheme", for establishing a new combined plant on the Clyde, below Glasgow and near the shipyards, able to obtain ore direct from sea-going ships, and disposing of coke-oven gas to Glasgow corporations. Sponsors of the scheme said the cost of slabs would fall from the existing average of £6. 12*s*. a ton to £5.[2] But after prolonged discussion nothing was done; whether, as some said, because makers thought the estimates of gain too rosy or were afraid of venturing capital when future demand was uncertain, or because, as others said, of mutual jealousies, desire to maintain the identity of firms and the multiplicity of offices which it implied, desire for excessive compensation.[3] In Sheffield, to take another instance, it proved impossible to bring Brown-Firth's into combination with the other armament firms.[4] There were other less well-advertised instances of ineffective negotiations; in the sheet trade, for example, where the stumbling-block is stated to have been the heavy compensation demanded by small firms—laudably, from one angle—on behalf of their salaried staffs. All these experiences lay behind the views of the Sankey Committee. And so long as the pattern of reorganisation which it sponsored was sound—in all essentials it seems to have been the plan placed before the Bank of England and accepted by it—the advice of the committee on the danger

[1] This case was specifically referred to in the Report of the Sankey Committee.

[2] From an unpublished record.

[3] It has been suggested that when firms objected to amalgamation on account of their desire for individual survival it meant that entrepreneurial services were supplied cheaply to secure this. Since the decision was often made by salary earners rather than ordinary shareholders, the argument is misleading.

[4] It is interesting to find W. L. Hichens, of Cammell Laird's, a keen supporter of either Bank or Government pressure to procure consolidation. He could express with feeling the view that vertical fusion had been the wrong sort of rationalisation, and that horizontal fusion was correct. As a shipbuilder he felt the urgency of getting cheap steel; being interested in the English Steel Corporation he would have liked no doubt to see Firth-Brown's dragged in. See Report of paper to Manchester Statistical Society in *Econ.* Feb. 15, 1930, p. 353. Firth-Brown's held out because they believed they had been able to remain more fully occupied throughout than the other firms, and feared the loss of individuality, and they were strongly entrenched in the new alloy steel trades. Firth-Brown's and the English Steel Corporation merged their stainless steel interests in 1934, and centred production at Firth-Brown's.

of introducing protection in advance of reorganisation was sound.

Nevertheless, there is a suggestion of inconsistency here which warrants examination at this point. The British industry was made up of firms of many sizes. Why would the imposition of a tariff be followed by a raising of prices which would strengthen firms which should be eliminated? Why could the larger firms not drive out the smaller; why were they not doing so in the difficult post-war years? The question was often asked alike by puzzled and interested observers, and it was pertinent. But it does not in fact touch a real weakness. The answer is to be found partly in the "imperfect competition" which has been analysed earlier—the extent of formal and informal integration and of the mingling of speciality and common-grade production had arrested the growth of the larger firms, and still limited the effectiveness of their competition; and partly in the mistakes and internal weaknesses and mal-locations of the big firms themselves, who often when they were the fruit of amalgamations suffered from internal divisions which robbed them of the advantage of their size; finally, in the inherited wealth of a few of the owners of high-cost plants, which contrasted well with the encumbered state of the great public companies. The actual conflict in Britain was not really between big efficient firms and small inefficients at all; for though there were efficient *plants*, there was hardly a firm in the industry in the 'twenties which at all points could be dubbed efficient.

While the argument for radical change thus did not carry within it its own refutation, the particular changes sponsored in these years *were* open to criticism, and damaged the rationalisation movement. There was in actual fact no coherent action by the banks as a group; in handling reconstructions, though they considered the competitive prospects of firms they assisted, the banks did not base their actions upon a common reconstruction policy; they were no doubt willing to valorise their "frozen assets" and reinvigorate their old customers by aiding the exploitation of such quasi-monopolistic competitive advantages as the firms possessed. Their attention was concentrated on firms,

especially on old firms, not on industries.[1] Within the industry it was complained that some firms which, being the first to succumb to bank pressure, were reconstructed and put "in funds" again, were notoriously given to breaking price agreements, yet made little technical advance; they increased the anarchy within the industry but not its efficiency. The outsider cannot check this; but certainly there was force behind the criticisms of those who were disturbed that the first-fruits of the Bank of England's intervention in the common-grade steel industry was the rebuilding of the Partington Steelworks; for though this was admirably done, the site precluded low material-assembly costs, while the local wire industry could have been fed by semi-products from areas making steel more cheaply. The choice of this site for the first rebuilding was due to its accidental connexions with the Bank of England, and although firms less happily off for funds were no doubt jealous when they deplored the transaction—in private—the influence of chance was reasonably disquieting. Quite clearly—though this was not, of course, the burden of complaint within the industry—the success or failure of this venture could hardly be a criterion of the desirability or otherwise of protection. And it reflected a weakness which seems traceable in most of the discussions of these years, a failure to recognise how vital the locational problems were. The plans for regional consolidations and specialisations manifestly were liable to check rather than encourage locational change. It was an advance that Northamptonshire was "booked" for tube making; but hardly more than a beginning. Some of the most fruitful structural changes in the industry had involved the reaching out of firms in the older to newer districts, notably of Welsh firms towards Lincolnshire. In Germany too this kind of thing had notably aided the development of Lorraine and Luxemburg before the war. Regional consolidations threatened to stand in the way of development in the newer areas and to limit the range of products they made. Fusions between firms in different districts did not necessarily advance

[1] The author is relying here on information given to him in 1933 by a high authority in one of the "Big Five".

locational adaptation,[1] but rigid regionalism was certainly likely to hinder it.[2]

How easily radical change as advocated in the Sankey Committee's report might go astray was shown impressively, by an odd coincidence a few weeks after the report's appearance, in a German committee's survey of the changes of this very kind which had occurred in the reputed home of "rationalisation".[3]

This penetrating study laid bare the weak ore foundation of the German industry in the 'twenties and the failure of its leaders to follow a policy appropriate to this.[4] The home market had recovered and expanded notably, partly as a result of State encouragement. But the capacity of the industry was expanded far beyond the needs of the home demand even when this was at its briskest—in 1927–8—and this expansion was accompanied by very expensive re-equipment introducing plant which greatly reduced prime costs but whose capital cost was only justified when it could be worked at a high rate of output. To do this necessitated large export sales, even at the peak of home demand, and in much of the trade these could only be made at the low prices determined by French and Belgian competitors, who had the cheap ores—and cheap labour. The lowered prime costs no doubt made it easier to get this trade, but the industry at its

[1] Cp. above, p. 372, where the relation of "United Steels" to locational change is considered.

[2] The advantages of regional concentration and specialisation would have probably been overwhelming but for the problem of location. It was suggested by Mr Harbord that giant works were not really vital for efficiency—that works making 300,000 tons per year (i.e. far larger than most British plants) were large enough if specialised on one type of product (Presidential Address, *J.I.S. Inst.* 1927, I, p. 42). But while narrow specialisation might suit a *plant* it is doubtful whether any *firm* would wish to embark upon it. It might not have been economical even for a firm with several plants, each specialised on a different product, since the demand for single products tends to vary more acutely than for steel in general, and the activity of units in the industry would probably have thus been even less steady than in actual experience. The argument for flexibility in rolling plant, adaptability to a wide range of products, is strong. Cp. G. A. V. Russell, *J.I.S. Inst.* 1934, II, pp. 25–126. Mr Russell starts by favouring plants of Mr Harbord's size, but most of his ideal examples are much larger.

[3] Used continuously in this text, and referred to as *Eisenerzeugende Ind.* in the notes.

[4] *Ibid.* p. 118–122.

busiest was not able to pay a "reasonable" dividend on ordinary shares, and there was no justification for throwing on to the home trade the burden of the capital cost of a vast export trade for which the raw material basis was lacking—a burden whose weight could be judged from the wide gap separating German home and export prices, which was reminiscent of the early fighting years of the young industry, but sharply distinguished from the practice of the late pre-war years when the industry had matured and was using the Lorraine ores.

Such was the indictment of this unusually frank report, which should have been a salutary if oblique contribution to British discussions. Unfortunately it escaped careful scrutiny,[1] and was usually supposed to imply the failure of "rationalisation" and to support those who had continued to advance the time-honoured plea that British markets were not suited to mass-production methods. Its bearing was of course quite different, for it was concerned with the pace, scale and timing of change, and it implied the need, not the failure, of rational control.

Kartells do not normally, as is sometimes implied, eliminate competition; they change its form. In the early post-war years German firms fought each other by integration, and at this stage their markets were so much in the melting-pot that quotas were out of the question.[2] After 1925 and the return of Kartells and quotas competition took different forms. Integration had often distorted technical development and raised costs, leading to needless duplication of equipment and much cross-freighting.[3] But the craziest of the forward integrations had collapsed, and the integration movement was replaced by another, less universal, for horizontal fusion, whose outcome was the Vereinigte Stahlwerke, sponsored by the steel units of the Stinnes combine, and finally also embracing Thyssens, and the Phoenix and Rheinische companies.[4] It was the professed object of this combine, which

[1] It was well summarised in *I.C.T.R.* in six issues, from Feb. 6, 1931 onwards. But the economists missed it, as they missed most of the hundred or so reports in this series; which present, be it added, an amazingly valuable review of German economic life on the eve of the Nazi Revolution.

[2] There is an interesting discussion in *Stahl. u. Eisen.*

[3] *Rep. on Econ. Cond. in Germany*, 1925–6, p. 56.

[4] *Ibid.*

had over half the German steelmaking capacity, to eschew forward integration and to achieve the maximum economies of concentration.[1] Efforts were made to bring all the great firms in. But they failed; and the old family firms—Haniel, Hoesch, Krupps, with some younger ones, e.g. Kloeckner's (a merchant's creation) and Mannesmann (specialised mainly on tubes)—remained independent, the chief of them notably integrated forward.[2] They had perhaps not made bad mistakes in the inflation period; at any rate they had no desire to go back on their traditional policy. So there was a marked conflict of structural principle in the late 'twenties, the years of so-called "rationalisation". And almost certainly the building programmes of these years were a projection of this conflict,[3] whose effect was all the greater because the capital market was no longer dominated, as before the war, by the great bankers. Firms were able to borrow—it might be more true to say were wheedled and lured into borrowing—from American bankers; and the bank co-operation traceable in the handling of large issues before the war disappeared. Vereinigte Stahlwerke, unlike some giants, adopted a policy in keeping with its size; by 1929 it had closed down eight blast-furnace plants, seven open-hearth steel works, and innumerable other mills and shops; railmaking was concentrated in one instead of nine works; export orders were consigned almost wholly to Rhine plants, to avoid railway transport, and so on. Concentration and "negative rationalising" went hand in glove with an increase of mechanisation which they were designed to render economic. In face of all this it was hardly possible for the other firms to remain idle, despite the restoration of the Kartells, since when agreements were to be renewed, reduced prime costs would be the basis for claims for larger quotas. Hence the adoption of much more highly mechanised production had to be universal; and it

[1] *Eisenerzeugende Ind.* pp. 129 sqq.

[2] *Ibid.* pp. 125 sqq. Gutehoffnungshütte, e.g. had within itself a market for 18 to 25 per cent of its output of finished steel (p. 133); and Hoesch worked up over 20 per cent of their rolled products (p. 127).

[3] This point, it may be stated to avoid any ambiguity, was not argued in the German report and cannot claim its authority.

involved expansion of capacity in the primary branches of most firms, associated with a new subdivision of production in the re-rolling trades, since firms extended their rolling programmes in order to consume their increased "make" of ingots. The danger was tacitly acknowledged in 1930, since shortly after the Stahlwerksverband agreement had been renewed for a second term its members undertook to refrain for five years from entering any branch of the home trade in which they were not at the time participating.[1] But for the time being, of course, firms were in no position to build extensively had they wished, since the supply of capital had dried up; the seductive "drummers" of the American banking houses, whose activities had created a veritable anarchy in the capital market, had returned home.

This was a rich experience for the English industry to study; and it certainly underlined the difficulty of introducing in the right proportions mass-production techniques which were dependent upon the use of units of plant whose capacity was large in relation to total consumption. But it did not dispute the economy of such techniques in correct proportions. And in several ways the British industry had more room than the German for the newest plant. It had more very old plant to replace, plant which had virtually no earning capacity, and whose replacement would lead to very great cost reductions. Interest rates were not so high as in Germany. There were foreign suppliers who could be displaced from the home market. And the industry could be based on raw materials at least as cheap to assemble as those used by the low-cost producers in France and Belgium.[2] As to the assertion that British consumers

[1] When firms defended their building policy they did so on account of foreign, not home, competition. E.g. *Eisenerzeugende Ind.* p. 169. But the truce of 1930 is sufficient to show that their explanation was at least incomplete. They probably did think, in the confused way common to manufacturers (and others), that they had a right to an export trade on pre-war lines and must be prepared to fight for it. Their individualism was manifested in their ownership of particular merchant firms, who sold Kartell products as agents of the Kartells, yet could put their clientèle at the disposal of their associated manufacturer if the Kartells broke up. Cp. Thyssen, *ibid.* p. 315.

[2] In Germany this was not a proved possibility at this time; the position is not certain now. Cp. below p. 465.

in contrast with consumers elsewhere normally wanted small quantities of odd sizes and specifications and of accurate quality at short notice, that the trade was thus essentially a jobbing trade, the simplest answer was given by the vast and growing import trade. British makers could not hold the trade in ordinary grades. Further, large-scale working rather facilitated the achieving of uniformity,[1] largeness of firms reduced the evil of small orders, while a homogeneous industry ceased to be a prey to the demand for immediate delivery[2] and could encourage the greater use of standard steels. These points have been argued earlier and need no elaboration; they were fully appreciated within the industry by the more active minds.

Neither the Sankey Report nor its German successor provoked anything in Britain save discussion; and while this proceeded in its leisurely and ineffectual way, the combatants still never really coming to grips, never thoroughly defining or realising their own facts or objectives, still less their rivals', depression interposed and diverted attention from long-range to short-range problems.

It would be otiose to trace the course of the "Great Depression". Among steelmaking countries those most severely hit were the United States and Germany, which witnessed the most extravagant and ill-judged expansions of instrumental capital, encouraged in the former by a veiled inflation, and in the latter by the prodigal American loans. American home consumption fell from over 54 to roughly 25 million tons; in Germany the fall was proportionately more severe, from 11·7 to 4·8 millions. In Britain and France the shrinkage was far

[1] E.g. grading of materials was eased; and more tests could be made in adjusting plant before production. Cp. e.g. *Proceedings of the Birmingham Metallurgical Soc.* vol. 7, p. 40.

[2] A few economists have regarded the ability of consumers to have an order rolled at a moment's notice as a virtue of the British system in the 'twenties. In effect it precluded the use of plant for purposes to which it was best suited; tended to maximise the amount of time when plant was idle—changing rolls; and since firms were constantly getting isolated orders for steel of a certain specification in quantities too small to use the whole "cast" of a furnace, it involved unnecessary stocking of ingots and avoidable reheating, and complicated managerial problems. All this was a manifestation of over-capacity but not an economic virtue.

less. This was only a minor advantage for the British industry, however, since Continental makers tried to make up in the British and export markets for their losses at home, and their lower costs allowed them easily to increase their proportion of world export trade. British imports rose slightly, British exports fell by over one-half, American by two-thirds, Continental exports by less than one-quarter. In the absence of price control Continental prices fell far more than was needed to secure business against British makers, and a period of violent mutual competition set in with French and Belgian export prices at length much below home prices, and the German export discrimination reaching 50*s.* a ton. Even so the British steel output fell proportionately less than the German and American.

But though some of the protected countries suffered more than free-trade Britain the situation was one which naturally gave victory to the Tariff Reformers over the rationalisers. The Bank, preoccupied with the currency, was in no position to sponsor reconstruction finance. On the other hand, the danger of dumping had been shown more impressively than ever, and the over-valuation of the pound had strengthened the case for a tariff in a way which was intelligible to the layman only inasmuch as it broke the ranks of the liberal econômists. Bewildered by an unfavourable balance of payments and all the associated financial problems, the majority of the public accepted willingly, even with relief, the assumption of power by a coalition of the old hands who were experienced in applying the method of trial and error in post-war economic politics, albeit with little enterprise and hardly any success; nor was it in a mood to question the merits of a policy of protection which has the inestimable benefit, for a publicist, of giving advantages which are more apparent than real.

Chapter XVI

A NEW START

The National Government conferred its first boon upon the steel industry involuntarily by failing to save the Gold Standard. Thereafter sterling was for some time undervalued, discriminating in favour of exporters and against imports from the Continental steel centres. The tariff came more slowly. The General Election of 1931 favoured the return of protection. But there were faces to save and pledges which required delay. In December Lord Runciman repulsed the industry's demand for high duties, reminding the House of Commons that while 180,000 workers made steel 1,800,000 used it.[1] In the spring of 1932, however, a protectionist policy was adopted, the detailed administration being based on the advice of an Import Duties Advisory Committee, among whose three members, by an odd irony (or was it subtlety of selection?) was Sir Sydney Chapman, who reviewed the Report of Chamberlain's "Tariff Commission" in 1904 with so little sympathy. Its first recommendation was that duties of $33\frac{1}{3}$ per cent should be placed on most grades of steel for a short period, their renewal being conditional upon reorganisation in the industry. The Committee's "case" for a tariff stood on two legs, a prosperous steel industry being deemed essential both for economic progress and national security. As for reorganisation, they wished to see machinery created to promote co-ordination and co-operation—both within the home industry and between it and its rivals—which would adjust capacity and prices to make the industry profitable, and would also lead directly and indirectly to the "maximum efficiency of production and distribution", viz. "the supply to the using industries of the right products at the right prices". Briefly, they aimed at national and international Kartells free from monopoly evils, plus some degree of national planning.[2]

[1] *The Times*, Dec. 10, 1931.

[2] *Report of the Import Duties Advisory Committee on the Present Position and Future Prospects of the Iron and Steel Industry* (referred to subsequently as *Rep. I.D.A.C.*), pp. 12–13; and *Recommendations I.D.A.C.* Cmd. 4066 and 4181 (1932).

Thus the steel industry at length received protection, though not quite on its own terms; and from the English standpoint the interest of its subsequent history centres very largely on the effects of this new start.

1. CHRONICLE

It is convenient to preface the study of these effects with a narrative of the industry's fortunes from 1932 to 1937. Such a narrative breaks into two periods, the first closing in the early months of 1935.

The imposition of the tariff, aided by the depreciation of the pound, had the immediate effect of giving to British makers a greater proportion of the home market for finished and semi-finished steel than they had hitherto enjoyed, so that although demand fell sharply in 1932 the ingot output of the British industry was higher than in 1931, while world output fell from 68 million tons in 1931 to 49 millions. In the next two years export trade hardly rallied, and there was a growth of Continental competition in the sheet and tinplate trades, the kind of unfavourable reaction in finishing trades which Free Traders had foretold. But home demand, now of especial value, revived steadily. This revival was many-sided—least in shipbuilding, most perhaps where the influence of "public works" expenditure was felt after the panicky economy of 1931–2[1]—but it was insufficient to keep the ingot makers, still less the finished product makers, as busy in 1934 as they were in 1929.

For all that, the capacity of the industry was considerably

[1] The output of motor cars rose from 1932 onwards; it had been checked, but did not fall noticeably in the slump. Merchant shipbuilding was virtually inactive in 1932; it revived, but very little, in 1933–4. Naval shipbuilding had been suspended in 1931–2, and a double programme was under weigh in 1933. There was a great increase in house-building in 1933, and a considerable revival in the building of schools and public buildings; factory building only revived a little in 1933, but much more in 1934. By this time road and bridge making were more active. The new uses of steel, e.g. for furniture and office equipment, domestic fruit canning, and pit props and arches, were making headway. The general tariff was thus only one of several factors encouraging expansion of demand, being most important perhaps indirectly, as a—partly irrational—source of confidence. Some of the statistics relating to the growth of consumption are gathered in *Stat. B.I.S.F.* 1937, pp. 50–1.

enlarged by rebuilding and new building in these years. The better trade, or the promise of it, which the tariff gave, particularly in the branches most subject to foreign competition, in conjunction with the process of financial reconstruction which had been at work for some years, increased the borrowing power and sometimes the earning power of firms, and most went ahead with improvements of their equipment. These, together with further amalgamations and financial reconstructions, constituted all the "reorganisation" which occurred in this period. Amalgamation was most noticeable in Scotland, where, as a result no doubt of the extremity of depression in shipbuilding, Colville's went far towards obtaining complete control of the steel industry of the region, apart from specialities.[1] In South Wales, Richard Thomas was able to absorb a number of tinplate works, of which several had hitherto flourished on imported semis. A scheme for Dorman Long's to absorb Cargo Fleet was defeated by shareholding groups in the two companies.[2] Only two of the building schemes of this period were concerned with the erection of big new combined plants: Stewarts and Lloyds' went ahead with their Corby plant, planned in 1929, and Guest Keen Baldwin's started a complete rebuilding of their Cardiff plant. Richard Thomas had it in mind to convert their Scunthorpe plant into a combined works making sheets by the new American continuous process, and to take their tinplate business into Lincolnshire; but this was only a project. Just as few new plants were built, so few old ones were closed down, these usually by multi-plant combines (such as Dorman's and Guest Keen's), who also specialised their remaining plants more than

[1] Colville's bought the plate businesses of Stewarts and Lloyds' and Beardmore's; and acquired the ordinary shares of the Steel Company of Scotland and of the Lanarkshire Steel Company. (The final steps were taken in 1936.) Stewarts and Lloyds' retained their tube trade, and Beardmore's specialised on high-grade forgings and castings. The Scottish Iron and Steel Company remained independent, making small sections, probably doing very little for shipbuilding; in 1939 it entered into a vertical integration with Baird's: *The Times*, June 3, 1939.

[2] The matter was taken to court, and is reported in *The Times*, Nov. 22, 1933 and sqq. Much of the opposition was concerned with the details of the proposal, and was not directed against the principle of consolidation. It is believed, however, that some opposition was really if not ostensibly based upon a fear, which was justified, that consolidation might lead to the end of steelmaking in West Hartlepool.

hitherto.[1] But subdivision of production was only a little reduced in the industry, and taking the building programme as a whole its striking character was its universality. It was the old policy of patching which predominated.

While these changes based on individual initiative were in progress a committee of the National Federation, set up at the instance of the Import Duties Advisory Committee, was trying to forge a new constitution for the industry which should provide for an extension of collective activity. In April 1934 the main lines of such a constitution[2] were agreed upon by the industry and approved by the May Committee, which had helped to formulate them. It introduced two main changes in organisation. First, the creation of a much stronger central body, the British Iron and Steel Federation (which was the National Federation in a slightly different form and with extended powers), to which the innumerable associations fixing prices in and otherwise controlling particular branches of the industry were to be affiliated. And secondly the appointment of an Independent Chairman of the Federation, who should have had no previous connexion with the industry and would thus be able to see it as a whole, unpreoccupied with the interests of a particular firm.[3] The Federation was given almost unlimited scope, but its relations with the affiliated bodies were not precisely defined,[4] and the constitution was no more than permissive. The work of reorganisation had yet to be done. Quotas, central selling, a levy to provide a capital fund to be used for plant improvements, export bounties, or other purposes—these and other proposals had been discussed without agreement. For nine months the creation of the new Federation appears to have

[1] Dorman's closed the Clarence steel plant shortly after Sir Hugh Bell's death; platemaking was discontinued at the Cleveland works, where the railmaking of the whole concern was concentrated; Acklam was specialised on semi-products. Guest Keen's shut down the Dowlais works, the oldest and most famous of the Welsh "hill" plants. The L.M.S. steel plant at Crewe was closed down in 1932 by an arrangement whereby the Barrow and Workington works bought the railmaking quota of the Crewe works. [2] It is printed in *Rep. I.D.A.C.* Appendix XIII.

[3] The Independent Chairman was to be appointed by a special Resolution of the Executive Council, which was composed of representatives of the chief firms.

[4] Indeed these bodies continued to fix prices without consulting the Federation.

been little more than a formal change; there was still much resistance to any central control. It was not until early in 1935 that an Independent Chairman was at length appointed, and this may be taken as the effective end of the first phase of post-tariff history.

Collective action had meanwhile advanced far more rapidly on the Continent. "Les grands chefs de l'industrie"—as the Chairman of a French steel firm put it—"ne sont pas extrêmement portés aux ententes; ils se déclarent prêts, mais en général, il faut pour les décider qu'ils aient souffert."[1] By the end of 1931 the severity of competition at home and abroad in shrinking markets, accentuated by the British departure from gold, sufficed; and in December a provisional agreement for the control of the whole of the steel trade was made. There were to be quotas based upon the trade of 1929–30; comptoirs were to be organised for all products; and no firm was to enter a new branch of trade for three years.[2] By the close of 1932 details had been worked out and agreed upon, and central selling, in the hands of nine comptoirs, was operating, not without friction and some evasion, for all the ordinary grades of steel. The effect is apparent in price movements, French home prices rising slightly and remaining considerably above the export levels. With this change in France the prospects of international agreement such as the Germans had wanted all along improved, and a period of anarchy in the Belgian industry, which brought home and export prices there down to half the 1929 figures by the end of 1932, swept away Belgian resistance[3] and paved the way to the first real European Steel Kartell, which was established in June 1933. Adopting the trade of the first quarter of 1932 as its basis this Kartell quota-ed the exports of a wide range of products,[4] supplementing but not absorbing the rail, wire and tube Kartells, which had survived the slump. Central selling

[1] Quoted by R. du Fou, *op. cit.* p. 112. [2] *Ibid.* p. 121.

[3] The Belgian banks exercised pressure.

[4] By the selection of the base year the Belgians were favoured. No doubt their price-cutting was thus in a sense rewarded. It was arranged that as the trade of the group rose from 6 to 12 million tons the Belgian quota should become proportionately less. Some products, e.g. sheets and tinplates, were still unregulated.

TABLE XL

Prices of Heavy Plates[1]

	"Gold" prices in shillings						Sterling		
	Belgian Home prices F.O.T.	French Home prices F.O.T.	German Home prices F.O.T.	Antwerp, F.O.B. General	Antwerp, F.O.B. For G.B.	G.B. realised F.O.T.[2]	G.B. realised F.O.T.[2]	G.B. Association prices Home[5]	G.B. Association prices Export[6]
1929 (Dec.)	121*	127*	160	125	125	159	159	165	155
1930 ,,	100	122	155	97	97	159	159	160	155
1931 ,,	67	105	132	65	65	110	159	160	155
1932 ,,	64	105	127	57	57	98	146	160	155
1933 ,,	77	110	127	81	68	105	156	160	155
1934 ,,	80	113	127	82	66	93	154	160	155
1935 ,,	61[3]	113	127	85	76	96	159	160	155
1936 ,,	71	105[4]	127	98	98	96	159	175	180
1937 (May)	94	110	127	122	122	106	174	213	220
1937 (Dec.)	106	110	127	142	142	113	194	213	220
1938 (June)	107	87	127	122	122	121	199[7]	213	202
1939 (Jan.)	106	96	127	112	112	117	204	196	202

* These are prices for Thomas steel. For open-hearth quality add *c.* 16*s.* (gold).

[1] Plate prices are quoted because a very reliable British figure can be quoted. But they are slightly misleading because the fall in (home) plate prices on the Continent after 1929 was less than the fall in prices for other products. This was particularly so in France and Belgium. Here e.g. the quoted home prices for joists were normally over 20 per cent less than plate prices from 1932–7; in 1929 the difference was only 12 per cent. The German quotation (1932–7) was 15 per cent less for joists than for plates, the British 5 per cent.

[2] Last quarter of the year. Yearly averages were as follows (in sterling): 159*s.*, 158*s.*, 157*s.*, 150*s.*, 159*s.*, 156*s.*, 156*s.*, 159*s.*, 184*s.*, 200*s.*, (1938).

[3] The result of depreciation of the belga, coupled with a policy of stabilising home prices. Government pressure was exercised to ensure that steel was not bought at "home" prices and then exported.

Notes 4–7 on p. 455.

and price control were instituted and export prices rose sharply above the trough of 1932–3, the increase being least in sales to England, in whose favour there was an important discrimination. The movements of prices of finished steel in these years and subsequently are represented, subject to the important proviso in note 1, in Table XL.

The second phase of post-tariff history was marked by the advance of collective action. This happened partly because the new organisation was there, its Independent Chairman, Sir Andrew Duncan—formerly Chairman of the Electricity Commission—fresh from an analogous experience in industrial reconstruction.[1] But the change of front was largely dictated by a change of problems. Reviving imports, for example, led to a special effort, with new State support, for an accord with the International Kartell; and, this achieved, central selling was extended in export trades and central buying of imports instituted. The Special Areas became a focus of political debate, and the steel industry was forced to take a line with regard to the transfer of production from old areas to new. Growing home demand made price-cutting pointless, and instead made it politically if not economically desirable to moderate the unavoidable rise of prices by subsidies for high-cost production.

Imports from the Continental Kartell countries fell to 643,000 tons in 1933, but rose to 912,000 tons in 1934. This was far below the pre-tariff level; indeed the import had rarely been lower since Joseph Chamberlain started his campaign; it was

[4] Depreciation here was largely offset by increased costs and prices.

[5] The rebate of 10*s*. a ton in 1929, and 15*s*. a ton from Jan. 24, 1930, allowed to consumers using British steel only, has been deducted. The association price was for three districts with relatively low delivery costs.

[6] The export price quoted for plates diverged much less from the home "association" price than the export price for bars.

[7] The lag between the rise of quoted and realised prices was due to the practice of contracting forward at definite prices. This is a traditional feature of of price history; but changed forms of contract are likely to lead to a quicker response in future.

[1] Sir Andrew Duncan was also a Director of the Bank of England. He was Coal Controller, 1919–20, and Vice-President of the Shipbuilding Employers' Federation, 1920–7.

twice as high in 1913. In a large measure it reflected a demand satisfied adequately and often best by Thomas steel, which was still not made in Britain. The price of this kind of steel when sold in England, though far below home prices, had risen by 25–30 per cent since 1932.[1] Nevertheless, the home industry resented these continued "inroads" upon what it thought should be its own preserve. The May Committee had held it "essential" in 1932 "to check the abnormal importations of competitive iron and steel that have been coming into this country in recent months at very low prices".[2] The British makers' interpretation of this was that normal imports should be lower than those of 1933, and to this end they opened abortive negotiations with the Kartell. These failing, they turned to the May Committee for higher protection, as a negotiating weapon, and their wish was granted; in April 1935 the 50 per cent duties which steelmakers had asked for in 1931 were at length imposed.[3]

The effect of this policy was immediate. Within a few months the British Federation had an agreement with the Continental Kartell. "A striking testimony to the efficiency of tariffs", as *The Times* said in its artless way.[4] Kartell imports into Great Britain were limited to 670,000 tons in the first year, thereafter to 525,000 tons.[5] The British industry was to have in future the same proportion of the total export trade of the contracting parties as it had in 1934. For its part the Kartell exacted a concession that its imports should enjoy a preferentially low rate of duty—20 per cent instead of the standard $33\frac{1}{3}$ per cent—which would make their trade more remunerative without helping the buyer.[6] The price and destination of the imports were to be determined by the home industry, though the Kartell's selling organisation in Britain was to remain the channel

[1] Above, p. 454. The figures are representative. [2] Cmd. 4066 (1932).

[3] See Debate in the House of Commons reported in *The Times*, April 13, 1935.

[4] June 12, 1935.

[5] There were quotas for specific products, which amounted to these totals. Cp. Cmd. 5201 (1936), p. 10.

[6] *The Times* argued that prices would be kept down by this (June 12, 1935). But the intention of the provision—to help the Kartell sellers—had been made clear by I.D.A.C.; Cmd. 4851 (1935), p. 5.

through which sales were made. The agreement required that licences be issued for the imports which were to receive preferential duties, and this, together with adjustments to avoid violating the "most favoured nation" clauses in commercial treaties, was provided for by legislation in 1936.[1] As an outcome of this accord the British Iron and Steel Corporation was formed—a commercial branch, as it were, of the Federation—to handle the collective purchases and distribution of imports and to take over and extend the rudimentary collective selling initiated by the British Steel Export Association in 1929.[2]

In the opinion of the May Committee,[3] and of Lord Runciman following it, these crucial changes would help the British industry in export markets, and of course at home, without hurting home consumers. Rising exports implied that protection had not hurt our export trade; and the technical progress that was being made in the industry was a definite token in favour of the tariff. The policy of high duties for bargaining purposes would manifestly increase employment in steelmaking itself; it would strengthen the exporting power of the industry by "increasing the general scale of operations"; and it would encourage a continuance of the work of re-equipment and reorganisation to maximum efficiency, which were now being delayed by the uncertain future but had otherwise been proceeding satisfactorily. Some sections of consumers would, the May Committee allowed, suffer a little; but they "have already in the main turned over to British material", and "taking the interests of the country as a whole...the advantages outweigh the transient disadvantages to a small section...and on a long view this (new) policy would best serve the interest of even this section".[4] The Federation had, moreover, given an assurance

[1] The story—with the administrative details—was told in a White Paper, Cmd. 5201 (1936). The plan had been made early in 1935 and sanctioned by I.D.A.C. (see Cmd. 4851 (1935)). Non-Kartell countries were allowed a quota at the lowest rate of duty based on their trade (in the products affected) in 1934.

[2] *I.C.T.R.* Dec. 13, 1929, p. 918. Orders above 250 tons for plates and sections were handled.

[3] Cmd. 4851 (1935) and Cmd. 5201 (1936), *passim*.

[4] In *The Times*' short summary of the Committee's argument (March 21, 1935) and in Lord Runciman's presentation of it in the House of Commons (*The Times*,

that the new tariff would not be used to raise prices[1], that Continental steel would not be sold at higher prices than British, and that it would "use its best endeavours to secure that adequate supplies of suitable steel are at all times available to meet the reasonable requirements of the British consumers" (even if this meant extra-quota imports) and to secure "the equitable distribution of imported steel...among all classes of consumers, without discrimination as to whether or not they are members of an affiliated association".

This apologia of the May Committee stood or fell by the judgment, not accepted unanimously within the industry,[2] that the reconstruction occurring in British steelmaking was adequate. The retarding of a few schemes of re-equipment—no details were given by the Committee—was not necessarily an evil. Foreign competition effective in face of a duty of $33\frac{1}{3}$ per cent was more likely to be a salutary check on bad patching than inimical to radical cost reduction. From another standpoint, if foreign competition made internal price control difficult, as perhaps it did,[3] this could only be on account of the high costs common if not universal in the British industry.[4] Finally, it is to be remarked that the British industry showed no signs of decline in face of this so-called discouraging competition. A Welsh M.P. actually advocated the increased duties by pointing out how well the industry had flourished on the lower ones.[5] And the progress had not stopped when the speech was made; the average monthly output of ingots was higher for the last

April 13, 1935), this mild recognition of immediate injury to some groups was eliminated. It was well known that great integrated firms took large tonnages of imported semis where they were available, and did not supply all their requirements from their own plants. It may be noted too that the May Committee, in referring to the low prices of Continental exports, wrote as if the low prices of 1932 prevailed in 1936. They were misinformed here, though it was true that the French industry, along with the German, now discriminated very sharply to secure export trade.

[1] Below, pp. 470–1.

[2] Below, p. 485.

[3] Foreign competition was effective in some trades both directly and indirectly; for re-rollers using foreign semis might undercut the association prices. When this happened integrated firms felt justified in doing the same. They could use this freedom to secure trade in controlled products by the device of the "coupled bargain".

[4] Otherwise the foreign steel bearing a duty of $33\frac{1}{3}$ per cent plus transport cost could not have been sold profitably—in any sense—in British markets, much of it at Birmingham.

[5] Mr Lewis Jones, M.P. for Swansea: *The Times*, April 13, 1935.

quarter of 1934[1] than for the year as a whole, and the first quarter of 1935 saw a further notable rise.[2]

When the House of Commons discussed this increase of tariffs a Welsh Labour member protested eloquently against steel-makers deserting the older districts in the name of reorganisation, and a Unionist from Cumberland demanded that home ores—that was Cumberland ores—should be protected. The demand was rejected—"it obviously would be quite impossible for the Government to say to an industry: 'You shall buy your raw materials from a particular source' or 'You shall locate your manufacture in a particular place'. It would be quite impossible to make such a proposal if, in addition, they were to say that their object in doing so was to render the industry more efficient."[3] Three months later the problem entered a new phase when Richard Thomas announced that the erection of a strip mill at Redbourne (Lincolnshire) was to start forthwith.[4] "The same low cost cannot be attained in Wales",[5] Sir William Firth stated. He revealed subsequently "that he had done everything possible—unsuccessfully—to influence the Government departments to prevent the erection of strip mills in another part of the country by people who were not interested in the tinplate manufacture".[6] Mr Bevin announced that the Unions would fight the proposed change; and a wave of indignant opposition

[1] Despite a holiday period in December.

[2] The figures were: average 1934, 738,000 tons; average last qr. 1934, 744,000 tons; average first qr. 1935, 790,000 tons.

[3] Speeches of Mr Grenfell, Mr Nunn and Dr Burgin: *The Times*, April 13, 1935, *loc. cit.*

[4] It would make 150,000 tons of sheets and tinplates a year at a minimum saving of £200,000. Sir William Firth at Annual Meeting, *The Times*, July 16, 1935.

[5] A year later Sir William spoke even more forcibly: "It would be absurd and against the national interest to build modern works in South Wales. Northamptonshire and Lincolnshire were undoubtedly the natural centres for the economic production of British steel, and the recent Welsh protests about the introduction of modern machinery in these counties showed that Welshmen were too apt to take a local view....They must be competitive if they were to survive against world competition, and they could not hope to make satisfactory international agreements if their plant was known to be incapable of low production costs": *The Times*, May 27, 1936. It was an odd speech, in the circumstances.

[6] *Ibid.* July 20, 1935. Speech to the South Wales Industrial Council. At the Annual Meeting of the South Durham Company (*ibid.* Dec. 19, 1935) it was announced that the new method of producing tinplates and sheets was being investigated by this Company.

swept across South Wales and beyond. The day of State intervention in industrial location had dawned.

Intervention in this instance was private and personal. As Richard Thomas planned to move, the Commissioner for Depressed Areas was making fruitless efforts to get Ebbw Vale restarted.[1] It was suggested that Richard Thomas should step into the breach, and Lord Baldwin, who had been "very unhappy" over the Lincolnshire plan, "helped quietly and out of the limelight to do his best in pushing along" this alternative proposal. He was successful. "The men who had contemplated" going to Lincolnshire accepted "that view of mine". "They felt they owed a duty to the community where their first works were for so long."[2] Richard Thomas made a dramatic change of plan, bought the only profit-making group of the Ebbw Vale Company's coal mines, the derelict steelworks and the associated ore fields,[3] and undertook to build a complete integrated sheet rolling works there. The sun of the Welsh hill plants refused to set.

Richard Thomas, in point of fact, owed no duty to Ebbw Vale: their old plants were 35 or 40 miles away. Indeed by creating employment in Monmouthshire they were hurting their old location at Swansea and Llanelly. Sheets might still be tinned there, but the steelmaking and sheet rolling would go. Even the tinning might desert the Swansea area—for Newport was the obvious town to finish and export Ebbw Vale steel. Hence much responsible Welsh opinion was not very happy about the new scheme.[4] In building at what was admittedly a higher-cost location than could have been chosen[5] Richard

[1] Annual Meeting of Ebbw Vale, *The Times*, July 23, 1935.

[2] Final Election speech, at Newcastle: *ibid.* Nov. 13, 1935.

[3] Article on "Sale of Ebbw Vale Steel Assets": *ibid.* Nov. 29, 1935. It is of interest that Ebbw Vale, having arranged a moratorium with regard to debentures and loan interest in 1932, had been able to obtain further advances of £500,000 from its bankers to keep going till 1935.

[4] I found the line taken commonly in Cardiff and farther West that if the work was to go to Ebbw Vale it had better have gone to Lincolnshire. Ebbw Vale now both rolls *and* tins sheets.

[5] The firm possibly had misgivings about its Lincolnshire steel plant, which was not a good one though of post-war construction. The lowest cost could have been obtained in Northamptonshire: the probable differences in cost of making pig iron at Northamptonshire and Ebbw Vale was about 5*s.* a ton in 1936. The Ebbw Vale

Thomas appears to have relied for their commercial security upon two sources of strength. They *had* sites in the low-cost areas —Lincolnshire and Northamptonshire—and could build there should severe competition arise. And they secured an exclusive control in Britain over the American Rolling Mill Company's patents in sheet rolling, which they could use themselves and, if they wished, allow other firms to use on a licence and royalty basis. With this behind them their plans became more ambitious; instead of 150,000 tons their sheet mill was to make 350,000 tons a year (and later again 600,000), much of it destined for motor-car bodies, and of a uniformly high quality hitherto not made in Britain.[1]

Hard on the heels of Ebbw Vale came Jarrow. Late in 1934 a syndicate proposed to build a new Thomas steelworks, rolling semis and small sections, on the site of Palmer's shipyard, where the steelworks had been idle since 1921.[2] Being unwilling to meet the competition of established firms it started negotiations through the Federation to secure a market for its product and financial backing from the leading firms on the Tees. The negotiations were fruitless,[3] and while they dragged on (for two years) Dorman Long's and Cargo Fleet both put down new mills to roll the kinds of product contemplated at Jarrow. So the scheme was dropped. Cost of production would have been

site was expensive to clear, but the old plant had a high scrap value, and the coal mines appreciated when price control was established. The G.W.R. moved some track to improve the site and may have given favourable rate concessions, and the firm was assured of having a concession from local rating authorities. Ultimately the Northamptonshire ore to be used at Ebbw Vale will be sintered in Northamptonshire and brought up to 50 per cent iron content before transport. Some Newfoundland ore may also be used.

[1] Sir William Firth's speeches at meetings of the company: *The Times*, July 16, 1935; July 16, 1936; Jan. 26, 1937. The Armco patents have been since ignored.

[2] I rely mainly on reports of debates in the House of Commons, correspondence in *The Times* from the chief protagonists, and published statements by the Federation. This account is a free interpretation of a vast literature in which frankness and reticence, eloquence and evasion, are curiously mixed.

[3] Not completely. The promoters made an arrangement with a Scottish firm, which refrained from a proposed extension; Consett was favourably disposed, so too Stewarts and Lloyd's—who among other things would have sold ore to Jarrow. The Federation (*The Times*, July 7, 1936) stated that "unanimity might have been reached upon the principle of a co-operative and integrated plant if located upon the Tees".

lower in the new plant than in the competing ones; but these had established connexions and a wide range of products, which would have enabled them, though they would have preferred to avoid it, to meet a low-price policy on the Jarrow front. Richard Thomas, possessing a large market already, and expecting not only to work cheaply but to make a product of exceptional quality, felt in a position to say: "We have informed the trade that it is our intention to work our new plant fully";[1] a new company to make a limited range of ordinary-grade steel could not do this unless its promoters were willing to make enormous financial sacrifices. Jarrow could have entered the Federation, but it would then have been bound by association prices—it would have lost its sharpest weapon for obtaining trade, unless the association fixed low prices for Thomas steel, which was unlikely.[2]

In its later stages the Jarrow project came into the front rank of political controversy. Hopes had run high in the depressed town, and the Federation was bitterly attacked for its negative, if not hostile, attitude. And though the agitation did not succeed directly, it played a big part in leading both the industry and the Government to provide for supervising, co-ordinating and planning further expansion. The Federation took the first step in March 1936;[3] firms planning expansion were to consult the Independent Chairman, and communicate the details of their projects, the markets they anticipated, the effect on costs, whether their action would make any other plant redundant, and so on. It looks as though the main impulse here was to avoid over-capacity, a nightmare ever since 1921,

[1] Prospectus, *The Times*, Jan. 27, 1937. The sentence continued: "but we have expressed our willingness to restrict production at our old type plant on a *pro rata* basis with old type plant owned by competitors, so as to maintain, in co-operation with them, orderly competition". The firm was, in fact, too optimistic. Its expansion proved unexpectedly costly, and in order to secure all the required money it submitted to a reconstruction of its board whereby the steel industry, the Bank of England and several competitors obtained representation. *Ibid.* July 5, 1938.

[2] Lord Runciman stressed in debate the fact that the Jarrow works could not have been excluded from the Federation. "It cannot be brought as a charge against the Federation that they can crush out a new applicant for entry into their federation." He did not discuss the significance of this. *The Times*, July 16, 1936.

[3] For all this paragraph *Rep. I.D.A.C.* pp. 36–7.

and a possible result of such schemes as Ebbw Vale. The next step was with the Government. In July Lord Runciman declared it to be the duty of the industry, in the interests of the nation as well as of itself, to plan its development, and announced that the Import Duties Advisory Committee had been given the additional task of inquiring into "the present position and further prospects of the industry".[1] Special reference was to be made to the lines of future expansion, and social as well as industrial considerations were to be borne in mind.[2] Within a few months the industry took the initiative again, and evolved a new procedure, "a very substantial advance", the May Report thought, whereby schemes of expansion were to be examined in detail by a Committee of the Federation and then submitted, with the Federation Report, for an examination by the Import Duties Advisory Committee.[3] The Federation further "recognised a duty" not merely to restrain but also to promote expansion in sections of the industry where it seemed necessary.

In its Report the May Committee was at pains to define the scope of such an independent supervisory body, as it had now in effect itself become. "Responsibility for the technical and financial soundness of any scheme in detail must rest with the originators and the Federation; the consideration of an outside body should in general be limited to the broader aspects necessary to a decision as to the compatibility of the scheme with the national interests."[4] These "broader aspects" embraced "location in relation to sources of raw materials, and markets, balance between home and imported materials, centralised versus scattered plants". The outside body should in particular

[1] Not unnaturally many people who had pressed for an inquiry doubted the appropriateness of this appointment, since the I.D.A.C. had been watching the steel industry's development since 1932, ostensibly with approval, and, rightly or wrongly, seemed in a large measure committed in advance.

[2] Report of debate in *The Times*, July 16, 1936.

[3] The Federation's was not a standing committee. The Chairman and President were *ex officio* members, and chose five members of Council not directly interested *ad hoc* to consider each case. Experts could be consulted. No power of veto was involved: "but it was believed that members would be morally bound to weigh carefully any opinion expressed" by the two Committees, "and to be guided by those opinions so far at any rate as they related to public considerations".

[4] *Rep. I.D.A.C.* pp. 40–1.

review the effects of changes upon labour and local government authorities. The limits suggested here hardly exclude from the supervisory body's contemplation any significant economic aspect of the schemes placed before it.[1]

When it drew up its report the May Committee had passed an opinion on four projects, and these, all of them approved, are a fitting epilogue to the stories of Jarrow and Ebbw Vale, because they show how the industry subsequently approached the problem of radical change. One was a new scheme for Jarrow itself. Electric steel-melting furnaces were to be put up, with rolling mills to handle their product and to re-roll semis from the Consett works, which was also to be a source of capital. Was it a stage in the transit of Consett to the Tyne?[2] Another was for the erection by the United Steel Company of blast furnaces, coke ovens and steel furnaces at Frodingham, the ingots to be rolled at the Templeborough mills (Rotherham) into material for the Birmingham market.[3] It recalls the apocryphal marching orders of the Russian Liberals: "One step forward and two steps back."[4] On the Clyde Colville's decided to add blast furnaces and coke ovens to their "pure" steelworks at Clydebridge, and to add to the melting and rolling capacity of this works. They accepted the policy of concentration but rejected the locational change suggested in 1929,[5] their reasons being that the saving on prime costs by the latter would be more than offset by additional capital cost, that the transition would cause a disturbance in production when it could ill be

[1] E.g. it is not possible to determine the social advantage of labour-saving plant without a knowledge of such financial details as capital costs, and a view on the correct principles in computing them.

[2] Consett had erected its most recent coke ovens on the Tyne.

[3] The announcement of this Lincolnshire plan gave new life to the Jarrow agitation; it was even argued that if there was room for a new plant in Lincolnshire there was room for one in Jarrow. The position of the final market could apparently be neglected.

[4] Cp. above, p. 359. The step would be sound if rolling Lincoln ingots in Sheffield is contemplated for a short time only.

[5] Above, p. 440. Concentration was accepted in a limited degree. Colville's extended and re-equipped their Glengarnock, Dalzell and Lanarkshire Steel plants. In building at Clydebridge they refrained from re-opening Mossend. But they did not concentrate all their plate rolling thereby.

afforded, and that on social grounds it was better not to shift. The fourth plan was for a continuous strip mill at John Summers' sheet-making plant near Chester. The steelworks here was a "pure" works.[1] "The proposals appeared to have been so planned,...both as to location and production, as to involve the minimum possible disturbance of employment."[2] All these plans, from one angle or another, reflect a high valuation of existing plant, and reluctance to depart from the traditional channels of trade.

When the May Report was published the "public mind" was in a mood to approve of this comfortable policy. For some time the hidden costs involved in changes of industrial location had been subject to increasing emphasis.[3] The steelmakers who patched old and ill-sited plants, in the established tradition, discovered they were humanitarians. They could point to the homes which their workers had bought. Who would take the responsibility of destroying the savings of a lifetime?—not to mention the value of all the machinery of civic life: schools and churches, town halls, water supplies, cinemas; and the community life. And then came the news that vast new steelworks were to be built by the State in Germany, sited on fields of low-grade ore which had hitherto been little used—at Salzgitter in Hanover, and in Baden and Franconia.[4] There was obviously strategy in this: concentration in Westphalia was vulnerable, and dependence on imported ores incompatible with self-sufficiency. But it could be persuasively argued that the new works—the first of them at least, in Hanover—would produce more cheaply than the existing German plants. The Mittelland

[1] Above, pp. 264, 361.

[2] *Rep. I.D.A.C.*, p. 40, points out that John Summers' plan would not increase materially the firm's output of sheets; their new mill would mainly replace old ones. It also noted that the Ebbw Vale plan, which would certainly add to that output, was launched without previous consultation either with the Federation or the I.D.A.C.

[3] See e.g. a good article on "The Shifting of Industry" in *The Times*, March 25, 1937.

[4] Article and leader in *The Times*, Aug. 13, 1937. For a rather fuller account see *Supplement to the Weekly Report of the German Institute for Business Research*, Sept. 22 and 29, 1937.

Kanal would bring coal cheaply from Westphalia to Salzgitter,[1] the ore was very cheap to mine, there were good markets for steel and by-products which were far closer to Salzgitter than to the Rhine, and recent technical developments in England[2] may have facilitated the cheap treatment of the ores. So the fires of criticism were once more stirred in Britain. *The Times* was ready to change. Ever since 1932 it had alternated uneasily between urging more rapid and radical change and accepting official assurances that all was well. "These were heydeys for the industry", it now observed,[3] with insistent demand and rising prices; "but another time will come when the export trade will be of greater moment....In the export trade price will win. There must be high industrial efficiency not alone in individual undertakings but in the industry as a whole. Old plant, merely re-conditioned works, and ill-sited undertakings, that may be good enough for today...will be found hopelessly inefficient and expensive when the trade tug-of-war begins." In these matters "the interest of an individual concern, or group of concerns" was not necessarily "identical with the interest of the industry or of the country". At Jarrow "the national interest was not made predominant". "Can the industry be left to plan for the country? The oversight that is required must be directive."

By this time home demand had risen to unexampled heights, and at a pace which no one had foreseen.[4] In 1937 it was roughly 40 per cent higher than in 1929.[5] Much of this was due to the direct and indirect effects of rearmament,[6] begun in earnest after the election of 1935; but there were other influences.

[1] And take ore to the Rhine plants. The transport cost was about 3 M. a ton in the 'twenties; probably lower now. Above, p. 415.

[2] Above, p. 169.

[3] *The Times*, Aug. 13, 1937.

[4] It is instructive to read, e.g., Sir Walter Benton Jones' address at the meeting of United Steels in Oct. 1934 (*The Times*, Oct. 5). He was explaining why "we need not regard the past year as a peak in the trade cycle"; "the steel industry in the future is likely to find fuller employment than in the past".

[5] Using the method of Table XXXIII, in 1929 home consumption was 8·6 million ingot tons; from 1931, 6·5, 5·1, 6·1, 7·8, 8·6, 10·7, 12·2 million.

[6] Steel was needed not only to make armaments, including ground equipment of aerodromes, barracks, etc., but to build factories to make armaments. The expenditure had the secondary effects of any investment. No statistical data are available.

The Government, for example, helped to stimulate a revival of merchant shipbuilding, and on the eve of the election enabled the railways to borrow money cheaply for extensions.[1] The machine makers took considerably more steel for their export business in 1935–6 than in the depression though still much less than in 1927–9.[2] The output of motor cars doubled between 1932 and 1936; the value of public building and school construction sanctioned was almost doubled between 1934 and 1936.[3] The substitution of steel for timber in coal mining went forward notably.[4] To take a smaller factor, the home demand for tinplate rose prodigiously.[5] At the peak much of the increased demand for steel was for stock.[6]

In these circumstances, though the export trade remained sluggish,[7] the productive resources of the British industry were fully employed as far as the supply of raw materials at each stage allowed and the limit on importations imposed in 1935 was waived. The British Corporation bought steel in excess of the

[1] Cp. Debate in *The Times*, Dec. 14, 1935.

[2] Machinery exports weighed 563 (000 tons) in 1929, 329 in 1931, and thereafter 301, 275, 338, 384 and 380.

[3] *Stat. B.I.S.F.* 1937, p. 51.

[4] The consumption of steel by coal mines was about 700,000 tons in 1937.

[5] The home consumption of tin plate rose from 270,000 tons in 1929 (and little more in 1934) to 405,000 tons in 1937.

[6] E.g. one constructional engineer, in a law case, gave evidence that he stocked 100–200 tons of bars normally, but 600 tons in 1936–7. "Other contractors did the same." *The Times*, Feb. 15, 1938.

[7] The course of export trade was as follows (000 tons):

	G.B.	Germany	France	Belgium and Luxemburg	U.S.	Total
1929	4380	5471	4212	4521	2450	21,034
1931	1979	3953	3546	3644	827	13,949
1932	1887	2157	2376	3300	366	10,086
1933	1922	1923	2652	3133	559	10,589
1934	2250	2434	3017*	3332	982	12,015
1935	2369	3095†	1819	3253	946	11,482
1936	2234	3556	1563	3186	1203	11,742
1937	2609	3631	2108	3893	3423	15,662
1938	1962	2773	1979	2467	2149	11,330

* Includes Saar to Feb. 17, 1935. † Includes Saar from Feb. 17, 1935.

agreed quota from the Kartell, and more imports came from the States and, what was newer, from Canada, India and Russia.[1]

TABLE XLI

Imports of Iron and Steel into Great Britain (000 tons), 1929, 1931–7

Country of origin	1929	1931	1932	1933	1934	1935	1936	1937
Sweden ...	74	32	36	51	64	61	87	105
Germany and Netherlands	562	471	179	92	154	84	144	155
Belgium and Luxemburg	1720	1481	1047	559	726	617	553	662
France ...	308	435	203	115	174	164	253	317
U.S.A. ...	70	13	7	4	9	10	18	315
India	28	—	103	118	126	67	144	215
Canada ...	—	—	—	—	82	92	144	164
Total (all countries)	2822	2845	1594	971	1367	1152	1483	2039

This was possible, very broadly, because the growth of home demand in Britain was exceptional; it was matched in Germany, and no doubt in Italy and Japan, but not elsewhere. The Belgian and Luxemburg industries had been built up mainly for export demand. Neither in France,[2] Belgium nor Luxemburg, as the following table shows, was production in 1937 equal to the level of 1929.

The British expansion was thus exceptional.[3] And the industry was unprepared for the pressure of demand. Its most critical mentors had advocated radical change to increase efficiency, not capacity. In the interest of concentration a little good modern plant as well as old plant had actually been dismantled.[4] The almost ubiquitous improvements after 1932 which have been referred to naturally offset this; but they had been made

[1] The Russian import is not distinguished in the published statistics.

[2] Labour problems contributed to this.

[3] Outclassed of course by Russia; but only Britain of the old steel centres urpassed its 1929 ingot output much by 1937.

[4] Stewarts and Lloyds', e.g., dismantled their post-war universal plate mill and used part of it for the cogging mill at Corby, and Beardmore's fine plant at Mossend was dismantled.

at a time when scrap was plentiful and amazingly cheap, and they were unbalanced—they increased the disparity between iron-smelting and steelmaking capacity which the war had generated. Thus the limit of expansion was determined by the elasticity of the supplies of scrap, of foreign pig iron, and of

TABLE XLII

Steel Production (million tons), 1929, 1931–7

	1929	1931	1932	1933	1934	1935	1936	1937
Great Britain	9·6	5·2	5·3	7·0	8·9	9·9	11·8	13·0
Germany and Saar ...	18·2	9·7	7·1	9·1	13·7	16·2	18·9	19·0
France	9·6	7·7	5·6	6·4	6·1	6·2	6·6	7·7
Belgium and Luxemburg	6·7	5·1	4·7	4·5	4·8	4·8	5·1	6·5
U.S.	56·4	26·0	13·7	23·2	26·1	34·1	47·8	51·6
Rest[1]	17·9	14·7	13·6	16·5	21·3	26·6	31·5	35·5
Total	118·4	68·4	49·9	66·7	80·8	97·9	121·7	133·3

iron-smelting and coke-making capacity. Rolling mill and steel-melting capacities were increased, but they were always ahead of their raw-material supply. Ore supply presented relatively minor difficulties, and these mainly on account of the Spanish Civil War. Production in the Basque country was temporarily checked, grading was less efficient, freights ran very high, and ultimately the ores themselves were dearer. Some Spanish-Moroccan supplies, never very important, were cut off continuously. On the other hand much larger supplies of Algerian, Tunisian and Swedish ores could be obtained, and the Federation bought ores from Brazil.[2] At home the older mining districts languished, but there was a great expansion in the East Midlands beyond the outputs of 1929.

The boom of 1936–7 largely stimulated the expansions at Clydebridge and Scunthorpe; it also led to an intensification of

[1] The remarkable increase here is dominated by Russian development, from 5·5 in 1929 to 17·2 in 1937. Japanese output rose from 2·3 in 1929 to 5·0 in 1936; Italian output had not fully recovered by 1936.

[2] The tonnage of ore imported was already higher in 1936 than in 1929, the average value 20 per cent less.

the policy of patching (which flourishes on booms), serving, for example, to justify the building of mills on Tees-side which ruled out the Jarrow prospect. But it is the profound effects of the boom on the collective organisation of the industry which are of most interest to the economist; for it led to a great elaboration of the machinery of price control, involving collective purchase of some raw materials, collective price control of others, and the suppressing of the effect of high marginal costs on price.

In 1931 free traders were denounced or ridiculed by protectionists, as the occasion served, if they suggested that tariffs would raise prices. Lord Runciman bade the Commons remember the consumers of steel. "His argument", declared Mr George Terrell as Chairman of the National Union of Manufacturers, "was based on the supposition that a tariff on iron and steel would necessarily put up their price. This is a proposition we entirely deny."[1] Thus when protection came the steelmakers were morally or politically bound to maintain existing association prices or to lower them. Since prices of finished products had fallen little if at all since 1929, and had often been fixed "to protect the weaker members";[2] since, too, costs were falling as a result of improved plant, and raw-material costs fell notably between 1929 and 1932; since, finally, real prices could often be raised with no change in nominal price by making association more effective, this stabilising of prices was not an unprofitable prospect.[3] During the negotiations preparatory to the "bargaining" tariffs of 1935 the British Federation repeated an assurance to the May Committee that, should

[1] *The Times*, Dec. 9, 1931. "He (Runciman) apparently knows nothing about the cheapened cost under methods of mass production, and he utterly fails to understand that you cannot have mass production without a protected home market." Incredible as it seems, Mr Terrell was anxious that the £ sterling should be restored to its old parity among the exchanges of the world; he apparently did not know that its depreciation had been highly protective.

[2] The phrase is adapted from an illuminating letter of Sir John Hunter's, *The Times*, Dec. 23, 1931.

[3] The Chairman of one of the chief British combines told me in 1933 that if his output was 70 per cent of capacity "present prices paid very well". The British industry was working at over 70 per cent in 1934. Costs had risen slightly.

material and labour costs allow it, a policy of low prices to increase consumption would be followed. The Committee thought that the near future held hopes of lower prices.[1]

But material costs were rising, and the unforeseen surge of demand in 1936–7 put stable prices, let alone falling prices, out of the question. The industry had to face the problem of framing the principles of a policy for raising prices which should be consistent with the declared character of British tariff policy. There must be no patent exploiting of monopoly, all the more so since much of the new business arose out of rearmament. In these circumstances the Federation, defining a policy to be followed by its affiliated associations, determined to "relate variations in prices to ascertained costs", and to submit the changes which it proposed to the Import Duties Advisory Committee. The Committee approved, and welcomed what it described in a soothing if not very intelligible phrase as a decision not to leave prices to "the uncertain play of supply and demand".

In June 1936 some letters of the Committee were published which shed light on the early working of the new policy. The Federation's first proposal was for an increase in the price of soft basic-steel billets. The official price of soft billets had fallen sharply from 137*s.* 6*d.* in December 1930 to 107*s.* 6*d.* two years later; it was still only 112*s.* 6*d.* at the close of 1935. There had been severe foreign competition, and perhaps prices were also lowered to meet the criticism that British prices had been far too high for this class of steel.[2] It is not surprising that the May Committee "were satisfied that a proposed increase of 7*s.* 6*d.*... was fully warranted by the rise in the cost of materials", and "recognised that in deferring any increase until now, and in limiting their proposal to this figure, the Federation has been giving sympathetic regard to the needs of consuming indus-

[1] Cmd. 5201 (1936), pp. 6–7.

[2] The position was more or less matched in the tinplate bar trade; the following were the ascertained prices of tinplate bars in South Wales:

1929	120*s.*	1932	92*s.*	1935	99*s.*
1930	118*s.*	1933	90*s.*	1936	109*s.*
1931	93*s.*	1934	95*s.*	1937	138*s.*

Prices of hard and medium billets fell little or not at all.

Ptries".[1] ossibly these billet prices were barely remunerative.[2] Two months later proposals for raising the prices of acid billets and basic pig iron were received more critically. There was "a lack of correspondence between the present prices of the different grades and the costs of production" of acid billets, and the case for a uniform increase in all grades was not made out.[3] Thus the May Committee showed that its examination of price proposals was not to be a mere formality, and it was also evident that established quasi-monopolistic advantages would be disturbed by the new system, and the policy would not necessarily work to the equal advantage of all participating firms. The May Committee at this point suggested further that piecemeal revision of prices was undesirable, and urged a comprehensive review. Within a short time such a review was placed before it, and an increase of all heavy steel prices proposed. The Committee approved, subject to the important condition that prices should now remain stable for a year,[4] since they were based on forward contracts for raw materials. But it deemed it worth pointing out that "the returns showed a wide range of costs", though it allowed that "in view of the unprecedentedly high level of demand...it was impossible to base prices solely on the working of the newest and most efficient plants".[5]

5201 (1936), p. 13.

[2] Billets are rolled in section mills when orders for sections do not keep the mills fully occupied; and traditionally billet prices have therefore been cut to secure orders. I was told by members both of the regular and excursion sections of the trade that prices in 1935 reflected the pressure of excursion traffic.

[3] Cmd. 5201 (1936), p. 14. This is interesting not only in the present context but as evidence of the variable rates of profit on different products in the industry whose importance has been urged earlier. The I.D.A.C. supported a proposal to change prices of some grades of acid billets, but not uniformly. Alternative proposals had been made by the Affiliated Society concerned (the S.M. Acid Steel Billet Association) and passed on by the Federation. [4] *Ibid.* p. 15.

[5] Dr Leslie Burgin in defending the movement of steel prices took a completely different line from I.D.A.C.; he "rejoiced that the price of steel had gone up" because price levels during the depression had been "uneconomic": *The Times*, Nov. 26, 1936. It looks as though he picked up the wrong brief. If so it is not an isolated instance in this department. E.g. Lord Runciman stated that to lower duties would not help to meet the situation arising out of the shortage of steel in Britain; shortly afterwards duties were lowered: *The Times*, Feb. 24 and March 3, 1937. Reduced duties alone could not *meet* the situation, but they clearly helped.

The increase in prices in the summer of 1936—12*s.* 6*d.* per ton on finished heavy products—was followed by a further increase of 3*s.* at the close of the year to compensate the steel-makers for the loss they suffered through the withdrawal of the railway rate rebates. Six months later a much greater increase occurred—32*s.* 6*d.* per ton on billets and rails, 37*s.* 6*d.* on joists, angles and plates. This reflected the continued rise of costs—actual and expected—but despite its magnitude it was moderated, as the earlier changes had not been, by the plans of the Federation to lessen the rise of costs and to spread the incidence of the costs of exceptionally dear materials. Prior to this change unofficial premiums were being paid for reasonably prompt deliveries.

The Federation's action at this time was a natural projection of its long-declared policy of stabilising prices. If prices were to be related to costs, then in order to maintain stable prices for steel it was necessary to stabilise the price of raw materials. But raw-material prices were not all equally amenable to control; and full activity in the industry involved the use of plants (and of mines) which were costly to work. If these obstacles to relatively stable prices were to be overcome the industry must subsidise high-cost production.

Home ore prices presented little difficulty; there is only a small free market, the bulk of the ore being owned within the industry. This is far from true of foreign ores; moreover, prices here are subject to the movement of freight rates. In this field there are no signs of stabilising. It was in the scrap trade that the first notable effort occurred. Since the war a greater proportion of scrap had been used in open-hearth steel furnaces, and for most of the time the market was favourable. The war had expanded the sources of scrap supply and it also left a legacy of scrap; technical progress was hastening the obsolescence of machines; years of falling output were naturally years of ample scrap supply;[1] and the rising proportion of imported semis used meant a rising supply of scrap from the re-rollers.[2] In

[1] Since the scrap available at any time was the product of an output greater than the current output.

[2] Scrap *in addition*, i.e., to that "in circulation."

the 'twenties the price of scrap was normally fairly close to that of pig iron, which was the natural condition of equilibrium, but in the acute depression of the early 'thirties it fell far below; indeed below the prime *cost* of pig iron to the best situated smelters. Under these conditions scrap gained still further at the expense of pig iron as a material for steelmaking; a greater tonnage of scrap was bought by steelmakers in 1933 than in any earlier year, and the purchases mounted sharply with the reviving demand for steel.[1] Towards the close of 1936 the old scrap—pig iron price-equilibrium looked like being restored. In the opening months of 1937 scrap suppliers were holding off the market, anticipating a further price rise, and there was a disposition to export.

At this point the Federation acted, and made an agreement with the chief scrap merchants whereby the latter received the sole right to supply the steelmakers, but agreed to abstain from exporting and to sell at a mutually agreed price, which was less than the peak price of 1929 and much below the price of pig iron.

The Federation's success is probably to be explained by the fact that scrap is a nuisance to its regular producers and that the export market was small. The general public was invited to add to the available supplies on patriotic grounds;[2] but it is improbable that merchants or scrap producers would respond

[1] Here are the figures (000 tons):

	Pig iron		Scrap	
	Own	Bought	Own	Bought
1920	2568	2121	1678	1460
1929	3087	1635	2112	2318
1933	1782	1040	1389	2910
1934	2521	1210	1797	3104
1936	3889	1672	2696	4219
1937	4386	1870	3076	4401

[2] An interesting letter from the Chairman of the B.I.S. Corporation was published in *The Times*, Aug. 3, 1937. The public who responded to advertisements were apparently disconcerted when they were not paid for the scrap they turned out. They were told that *if* they *were* paid, this "might take away the livelihood of some small trader"; and that they could at any rate be certain that the scrap which they were now able to get rid of went to British, not foreign, steelworks. "National policy requires that the costs of steel products...should be kept as low as possible." No record of profits was appended.

to such an invitation when steelmakers' profits were good. Having a monopoly, however, the merchants were able to look after themselves; and they no doubt obtained an implied security against a fall of prices such as occurred a few years since.

After scrap, coke. The Sankey Committee had detected a deficiency of coke ovens in 1930, and though much new building was undertaken from 1933 on, supplies fell short in 1936 and shorter still in 1937. The result was a sharp early rise of prices in 1936, followed by a persistent rise in 1937 to famine prices. The price of coking coal moved in sympathy, but more moderately.[1] The Federation was unable in this instance to establish a low price as with scrap, but early in 1938 negotiated prices considerably below the peak, though stable for a year.[2] Hitherto the coke makers had not acted in concert; it is possible that on this occasion they may have feared a falling off in demand through 1938 while several new plants would be coming into operation.

Two forms of subsidy to high-cost production were employed. There was a very sparing—in practice negligible—encouragement of the use of discarded plant to meet the "peak" demand. Of much greater importance was a system whereby the Federation purchased foreign scrap and pig iron at high prices (if need be) but sold them at "home" prices to members of the Federation, the losses being made good by a uniform levy on every ton of ingots produced,[3] not in any way proportioned to the advantage derived from the scheme by individual ingot producers. An effort was made to check the rise in imported scrap prices by an agreement with most European steelmakers whereby com-

[1] Coal prices in general were rising. Average proceeds were 15*s.* 6*d.* for the first two quarters of 1937, then 15*s.* 10*d.* and 16*s.* 7*d.* *Coking* coal prices moved much faster; in Durham the price rose from 14*s.* in Jan. 1936 (coke 19*s.* 6*d.*) to 17*s.* in Dec. (coke 21*s.* 6*d.*) and to 24*s.* in May 1937 (coke 32*s.*, June 35*s.*).

[2] Later in 1938 a further agreement was made, whereby coke prices for members of the Steel Federation were to be governed for some years by a sliding scale, a reduction of £1 per ton of steel bringing a fall of 5*s.* a ton of coke. The *initial* price for 1938 was lower than that fixed earlier, but *above* current market prices.

[3] With the exception of part of the output of one firm. The levy ran into several shillings a ton. The total burden can be guessed from the tonnages and average values of scrap and pig iron imported in the latter half of 1937, but this was not all carried immediately, and a levy was still being made in 1939.

petitive buying was avoided; nevertheless, most of the scrap was bought at about £5 per ton: the home price was about 65*s*. The pig iron rose to almost £7 (against a home price of 95*s*.).

These policies were noticeably favourable to the firms relying largely on scrap. At a time when shortage of supplies would normally have made them the least favoured producers the Federation's action actually reversed the position, and—partly with the financial assistance of their rivals—enabled them to secure their chief raw material at a price almost certainly lower than the cost of making pig iron, save in the two most favoured districts. Thus the profits of Clydeside, for instance, bore a far more favourable relation to those of Middlesbrough than would have occurred had raw-material prices remained competitive.[1]

This did not mean that Clydeside made higher profits than it otherwise would have done. For had the same output been secured with a free market in raw material, prices would have perforce been higher. How much—or for how long—cannot be judged. The following table suggests roughly the contrasted trends of marginal costs and prices at the peak of the boom, and it is probable that the marginal costs *for the industry* were not affected by the Federation's policies.[2]

The full significance of these figures depends on the proportionate importance of the items of cost, which varied from district to district and from year to year. Labour and fuel, for example, were used more efficiently in 1937 than in 1929; but more of the ore used in 1937 in making basic pig iron was imported ore, and more scrap was used in making basic steel.[3]

[1] It was argued that low scrap prices might induce smelters to lower their costs, while to put a levy on *scrap*, not *ingots*, might lead scrap merchants to seek higher prices.

[2] All the output of 1937 save roughly 1·5 million tons could have been made without importing pig iron and scrap; the *cost* of adding this final (or marginal) 1·5 millions must thus be judged from the cost of these imported raw materials alone.

[3] Data in *Stat. B.I.S.F.* Using the method of Table XXXVI for output, the Ministry of Mines estimates of coal consumption, and the Federation's wage statistics, the consumption of coal in steelmaking (iron smelting excepted) fell from 1·02 to 0·82 tons per ton of product, the productivity of labour rose from 58 to 70 tons per man per year, and average labour cost was about £2·6 per ton of product in 1929 and £2·7 in 1937 (iron smelting excluded).

TABLE XLIII

Wages, Raw-Material Prices and Steel Prices, 1929–38

(1929=100. Yearly average save when specified)

	Price per ton in 1929	1933		1937	Dec.	1938	Dec. 1938
Labour[1]		99	102	110	118	122	122
Ore, Home Basic[2]	3s. 7d.	88	96	104	112	114	114
,, Imported[3]	22s.	75	76	103	125	127	127
Scrap, Home	65s.[4]	58	81	102	107	103	94
,, Imported[3]	64s.	67	88	151	151	151	151
Coal[5]	13s. 10d.	97	106	114	120	125	125
,, Coking	15s. 11d.	81	90	143	144	137	135
Coke[6]	19s.	69	114	170	197	158	145
Pig iron, imported[3]	73s. 6d.	75	93	143	140	152	
Steel Prices							
Plates realised	159s.	100	100	116	122	126	128
quoted	165s.	97	108	121	129	129	129
Tinplate bars realised	120s.	75	90		126	125	125

Taking such general changes into account it is likely that for 1937 as a whole average prime costs and average realised prices showed roughly the same percentage increase over their 1929 levels, that at the end of the year the percentage increase of costs was the greater, but for 1938 the increase of prices.[7] Firms using mainly the cheaper English ores, and mining their

[1] Based on the percentage additions of the sliding scale. The column deals with the price of labour, not with weekly earnings or labour cost.

[2] *Reports* of the Secretary for Mines.

[3] *Trade and Navigation Returns*. Variations in iron content were probably small. On account of long contracts quoted prices are not satisfactory.

[4] The price of scrap rose much above this on the Clyde.

[5] Ascertained average receipts. [6] Durham prices have been used.

[7] The following comparison of the cost of labour and chief raw materials for 1 ton of heavy rolled steel with the prices of plates is necessarily tentative (1929 = 100).

	1933	1937	Dec. 1937	1938	Dec. 1938
Costs	78	117	127	121	114
Prices, realised	100	116	122	126	128
quoted	97	121	129	129	129

In Jan. 1939 the quoted price fell to 119. The "spread-over" scheme had passed some of the peak cost burden from 1937 to 1938–9, but the quantity is unknown. Angle, joist and bar prices (quoted) rose more than plate prices between 1929 and 1937: hence if anything the text underestimates the rise of prices in relation to costs.

own coking coal, or even merely making coke, obviously worked to great advantage in 1937.[1] For steel made wholly from imported pig iron and scrap the average material and labour cost in 1937 was probably about 33 per cent above the cost in 1929.[2]

Late in the autumn of 1937 the Federation took another important step in price policy. Since the price changes in May costs had risen—more possibly than had been expected; and on a cost-plus-profit basis there was a case for higher prices. Continental makers had raised their export prices above the British home level; British makers thought it unwise, but pointed to it with satisfaction to rebut accusations of monopoly excess.[3] Yet there were also signs that demand had reached its peak. Activity in shipbuilding, building and motor-car making began to flag. Rapidly falling prices on the Stock Exchange and in commodity markets cast a threatening shadow. Export inquiries fell off,[4] and American sellers, in face of a collapse of home trade, swooped upon the international market where famine prices had been established.[5] Hence from one angle the Federation had to consider whether to raise prices again, from another whether to lower them. It decided to declare the existing prices stable to the close of 1938. The grounds for this decision can only be surmised. Most likely the prospects of a slump at home were "writ small"; chiefly on account of rearmament, though also because declining demand for steel was thought to result partly from the anticipation of falling prices and a speculative postponement of purchases, made possible in some cases by accumulation of stocks. There was a great volume

[1] Prime costs not traced here (e.g. of electrical power and limestone) rose on average less than the costs recorded. An equi-proportionate rise of prime costs and prices meant a growth of the margin between them; but many items of "on costs"—rents, rates, selling costs—probably grew lighter per ton as output rose.

[2] If this is at all accurate it suggests that prices must have risen at least 45*s.* higher at the peak—but not throughout 1938—but for the Federation's policy. Those closely in touch with the position thought the real figure £3.

[3] There were official premiums charged with the official cognisance of the International Kartell, and further unofficial premiums.

[4] The December export was below the monthly average for 1937, in contrast with the position in 1936.

[5] Cp. above, p. 467.

of orders actually on the books in most branches of the trade; and stable prices were at least as likely to sustain demand by eliminating uncertainty as to depress it owing to their height. The common suggestion that the Federation was merely trying to sustain a price on a falling market was far too unsubtle; some of its shrewdest members expected stabilisation to be the prelude to a new upward trend.[1] Rising prices were of course ruled out for the moment. They would, moreover, have been a hindrance to the negotiation of price agreements with suppliers of raw materials.[2] Moreover, it was recognised that the cost-plus-profit policy involved a danger which had been exemplified in the war, and which many who remembered that experience wished to avoid. Management would become slack if an increase in cost automatically led to an increased price; it was vital, for the healthy working of the Federation's system, that this should be avoided.

When the Import Duties Advisory Committee drew up its Report in May 1937 the sophistications of price policy resulting from the slump were only germinating. The proposal to subsidise high-cost *works* was briefly discussed and the risks it involved noted.[3] The forms of subsidy which really proved immediately significant did not come into the picture. But the Committee discussed in some fullness two other aspects of price policy—the use of a "Central Stabilisation Fund" to subsidise exports and the use of "loyalty rebates" to strengthen the hold of the Federation over the trade—and though these were not very live problems in the boom, their analysis may fitly conclude the narrative of recent change.

In their early days, it has been seen, "loyalty rebates" were mainly used—without success—to combat pre-war foreign competition. They could still be used for this; but the Federation

[1] The Federation's policy of buying raw materials at high prices appears to have been based on too sanguine a view of the near future. Cp. Mr Stanley, to the House of Commons, *The Times*, May 23, 1938.

[2] At the same time long-period stabilising of selling prices might lead to a parallel stabilising of raw-material prices at a higher level than they would otherwise have sustained.

[3] *Rep. I.D.A.C.* p. 51.

advocated them chiefly as a means of strengthening the solidarity of the home industry. It encouraged the adoption of schemes "in the comprehensive form according to which an association of consumers undertakes that its members shall buy all their requirements from the members of an association of producers at the previous stage".[1] The significance of this is manifest. It gave the heavy steelmakers, for example, enormous potential power over the re-rollers; for these could be forced not only to buy from home or controlled sources but could receive unfavourable treatment if they chose not to abide by the association control of the prices of their finished products.[2] The May Committee approved of loyalty rebates because it approved of association and price control; from this standpoint the "outsider" was objectionable because he hampered the work of bodies who were advancing the welfare of the industry by market and technical research, by standardisation, etc., and because he benefited from the restraint of other members in his trade without playing his part, selling just below their controlled price and thereby keeping himself fully employed. The dangers involved were of course manifest; German Kartell history had made them familiar. The Committee recognised a need for impartial supervision (which it had itself apparently exercised) and even for statutory control.[3] So far, it averred, "the system had not been improperly used to any appreciable extent".[4] These were years, however, when exploitation was least likely, and the testing time would come when orders fell off, and firms integrated forward might be tempted to hamper their "pure" rivals in the finishing (e.g. re-rolling or constructional) trades.[5]

[1] *Rep. I.D.A.C.* p. 55.

[2] The system of relating prices to costs made it difficult to employ the familiar German tactics of attacking re-rollers by high prices for semis; which the English re-rollers had in fact feared. But it was possible to attack some re-rollers—one in particular—by forcing them to sell at a fixed price, since they would then lose a main weapon in securing new customers.

[3] The consuming groups would not be wholly safeguarded even if price control extended to the whole range of products made by all the firms affected.

[4] *Rep. I.D.A.C.* p. 57.

[5] There was some possibility of exploitation of consumers—but not through price policy—at the peak of the boom, since integrated firms might supply all their own needs first at a time when supplies were short. The Federation, which

The second new element of policy discussed in the Report of 1937 was that subsidies out of a Central Fund should be given by the Federation to certain sections of the industry to encourage export trade either in those sections or in manufacturing industries whose raw material was largely provided by them. Subsidies were, specifically, to be used both to "assist and *expand*" export trades.[1] The Advisory Committee supported this on two grounds. First, it argued familiarly that "as long as the price obtained covers actual works cost (material and wages) and makes some contribution to overheads, however small, the overall costs of home sales are less". This was true so long as export trade would occupy capacity which would otherwise be idle; it was not true if export orders were to be concentrated, as some people recommended, in the best plants, nor did it justify extensions of capacity to cope with exports, unless this allowed the use of methods precluded by the smallness of the home trade in some particular product. The Committee's second argument, which allowed for greater discretion in the use of subsidies, was that if the alternative to subsidies was the gradual relinquishing of export trade, then subsidies might be the lesser of two evils, particularly if they should prove to be the prelude to international agreements which eliminated the ubiquitous subsidising of "neutral" steel-using industries. This argument, unlike the first, set no precise limit beyond which subsidised discrimination was clearly wrong; the matter was one for long-range guessing. Thus far, it will be observed, the "case" for export subsidies was merely the "case" for discrimination; subsidies required in addition that it was good for the industry that certain firms should take export orders when it was not, or not obviously, to the advantage of those firms themselves. This would happen most clearly—the point was not discussed in the May Report—first, where a central selling organisation found it desirable so to

was pledged to an equitable distribution of imported steel, also set up a department to cope with the distribution of home-produced steel, and it was intended to protect unintegrated users. The system apparently did not work perfectly. Cp. Chairman of Richard Johnson and Nephew (wire makers), *The Times*, May 24, 1938.

[1] *Rep. I.D.A.C.* p. 54.

distribute orders that some firms received a larger proportion of low-priced export orders than in the past, and secondly in a boom period, when, in the absence of central selling, some firms might have to choose between selling in an unsatisfied home market and maintaining less remunerative export contacts.

Export subsidies remained merely a plan when the May Committee reported. Nevertheless, export policy was for all that possibly the industry's chief perplexity, though decisions did not seem urgent in 1937. The British industry's position had notably deteriorated since 1929. Collectively, the chief Continental exporters had continuously secured a much better percentage of their 1928–9 tonnage in the export trade than had the British, though individual fortunes had fluctuated.[1] And their relative gain could not be shown fully in this way, for it is to be recalled that all had lost much by the closing of the British home market, the big Saar export to Germany had ceased to be an international trade after 1934, while Belgium had virtually ceased to consume French semi-products. The Continental gains were made mainly in "neutral" markets, and were very widely spread. In South America, for example, British trade fell from roughly 560,000 tons in 1929 to 260,000 in 1937; the Continental fell from 1,170,000 to 1,087,000. In Baltic markets British trade rose from 216,000 tons to 237,000; Continental from 1,045,000 to 1,372,000. In the privileged Empire markets British makers held a constant proportion of the trade. After the agreements with the European Kartell in 1935–6 the pressure of Continental selling ceased to be immediately disturbing. But there were other problems, which grew more disturbing. In 1937 there was a formidable rise of American exports. Negotiations were opened for price and quota fixing; but the prospects were doubtful, both on account of the internal divisions of the American industry, and because American makers, the bulk of their trade being at home, might prefer to make occasional raids into the export markets rather than hold a stable proportion of the trade. But America was not the only nor perhaps the chief menace outside the European

[1] Above, p. 467, n. 7, for the details.

Kartell. Iron and steel making became ever more dispersed. New Zealand, Iran, Eire, Turkey, Greece and Brazil were about to join the ranks of the producers, favoured almost always much more by tariffs than by natural resources. Canada, India, Australia and South Africa advanced their output slowly; Russia and Japan with great rapidity. Sweden made more steel in electric furnaces than Great Britain in 1937.[1] The export market was thus narrowing geographically; and some of the newer or growing producers were also exporters. India sold a lot of pig iron abroad.[2] So did Russia.[3] Russia sold a little steel too; and so did Japan.[4] These exporters had modern plant everywhere, and very cheap labour. And for Russia, as for Germany, it could not be assumed that costs, even prime costs, would have a very intimate bearing on price.[5]

2. EPILOGUE

The post-tariff period showed unmistakeably the ineffectualness of the Sankey Committee's Report. But if its policy of radical reconstruction both of firms and of plants was well judged, then the subsequent history of the steel industry, despite superficial appearances, was one of retarded development, and British steel making and steel using were still handicapped by needlessly high costs in the later 'thirties. There had been a great increase in efficiency[6], but most was achieved by improving details and parts of plants, relatively little by concentration or translation.[7] The fundamental weaknesses—as the Committee thought them—remained.

[1] The British output of steel made in electric furnaces was 215,000 tons in 1937. The United States made 845,000 tons; Germany, 706,000; France, 316,000; Sweden, 253,000.

[2] 449,000 tons in 1929; 574,000 in 1937.

[3] 761,000 tons in 1936.

[4] Russia exported 53,000 tons of steel in 1936. The total Japanese export is not published in the *Stat. B.I.S.F.* 1938; but Indian trade statistics show an import of Japanese steel starting in 1930 and rising to 27,000 tons in 1937.

[5] It is stated that in negotiating the tinplate quota agreement of 1936 the German delegates stated that they were going to continue exporting at their current level—they had been vigorously price-cutting—whatever the cost. A similar position seems to have occurred in the tube trade.

[6] Cp. above, p. 476, n. 3.

[7] Cp. a useful survey of the main changes in 1938, *I.C.T.R.* Jan. 20, 1939, p. 107.

The subdivision of production had only been appreciably reduced in Scotland, and here the elimination of plants was much less noteworthy than the elimination of firms. On the North-East Coast, where the boards and the banks of the two largest companies thought amalgamation the right prelude to physical reconstruction, groups of shareholders rejected the proposals. Several small firms actually increased the range of their programmes,[1] and in some directions there was a decline of specialisation.[2] The geographical distribution of production changed very little after 1929, as the following table shows:

TABLE XLIV

Regional Distribution of Steel Production (percentages)

	1913	1929	1935	1937
N.E. Coast	28	23	21	22
S. Wales and Monmouth	23	24	19	20
Scotland	19	16	13	15
Sheffield	11	13	14	13
Lincolnshire	3	8	11	10
Lancashire, Cheshire, etc.	7	8	9	8
Black Country	5	6	7	5
N.W. Coast	5	2	3	3
Northants	0	0	2	3

There was still in 1937 a dearth of modern blast furnaces,[3] and too few all told for the steel capacity of the country; the revival

[1] E.g. Barrow—not an isolated instance—had been largely specialised on rails; in 1933 it set out to "produce the widest range of products (including rails) within our capacity" (the firm's output was about 40,000 tons per year). "As compared with rationalisation, which has certainly not stood the acid test of these bad times, being dependent on mass production, besides being too rigid and out of touch with the human equation, diversification postulates elasticity, close personal touch, greater productivity in bad times and in good times the choice of the most favourable markets": Meeting, *The Times*, July 1, 1933. See also *I.C.T.R.* Dec. 4, 1936, p. 981.

[2] This was offset slightly by the improvement of machinery to distribute orders so as to give good rolling programmes or eliminate cross-transports. Allocation of export orders grew more effective, and in 1937 a Supplies Committee was set up to do something for the home trade. The primary object here was to speed up production.

[3] *Rep. I.D.A.C.* pp. 15, 42. The average make per furnace rose 45 per cent between 1929–37: far below German and American averages, it came near the French.

of the Thomas process was slow; and though there had been a great increase in coke-making capacity—perhaps too much—the central units talked of in 1931 had not been built, and many of the new batteries were too small to realise all possible economies.[1]

If the industry had been left to itself, with the tariff, this is precisely the kind of result to be expected. The Sankey Committee had supposed that in the existing conditions of "imperfect competition" the effect of protection would be to delay reorganisation and "allow firms which should disappear to continue". The appeals by strong firms for an "Enabling Bill" to allow a majority to coerce an unwilling minority indicated that this forecast was correct. The distinguished steelmaker Mr Henry Summers, who enlightened the public more than most of his colleagues, described the situation with a refreshing clarity. "For nearly two years", he wrote in 1934, "the steel trade...had been drawing up schemes which, if adopted, could only prove futile and abortive. The main objects...were to bolster up redundant and obsolete plant, and by rings and quotas to put up the cost to the consumer....Even the majority were unwilling to adopt what was best for their industry. Questions of position and salaries not infrequently blocked the acceptance of economic organisation."[2] This criticism from within harmonises admirably with the forebodings of the Sankey Committee.

But these forebodings had contemplated protection without State supervision. The reimposition of a tariff was, however, accompanied by the appointment of the May Committee, and reorganisation had been declared an essential condition if protection were to be permanent. Why then had the type of reorganisation which was, as it were, sponsored by the May Committee so little likeness to the changes advocated in 1931?

There were ostensibly two reasons. First, the advice of the Sankey Committee was probably distrusted. Its report was never popular. Politically it fell between two stools, for while it did not go far enough for the Tariff Reformers it went too far

[1] *I.C.T.R.*, Jan. 15, 1937, p. 98.
[2] Letter in *The Times*, March 17, 1934.

for the Free Traders.[1] Industrialists no doubt disliked its frank invocation of financial pressure, though in this it sinned in company with the more illustrious Macmillan Committee.[2] And, as has been seen, there was, for plain but not good reasons, a marked reaction against the radical type of policy it advocated, a change of fashion. "The talk of the inefficiency of our industries," as the chairman of a small steelworks put it in 1933, "of overproduction, or of rationalisation—all of them smoke screens started by people with axes to grind—had died down, and it was now recognised that our misfortunes have all been due to the deflation of our currency."[3] By the side of this reaction against the *strategy* of the Sankey Report there was another—better founded—against its tactics, its inclination precipitately to "scrap and build". There are many passages in the May Report which imply that the plight of the steel industry was due almost exclusively to the inequitable terms of international competition, hardly at all to the unavoidable strains and stresses in its own internal structure.[4] At the same time the Report suggests that the Committee was substantially in agreement with the policy of concentration;[5] inasmuch as it differed from the proposals of 1930 it was in part because of disagreements over specific details, but mainly because it took a view of the time-factor different from the Sankey Committee's.

The second influence which helps to account for the degree of divergence between the Sankey plan and the reorganisation realised in these years was that there was no acceptable means of coercion which would have had immediate effect, once the

[1] Some folk thought its compromise over the tariff was the factor which determined the Government not to issue the Report: *Ironmonger*, Nov. 29, 1930, p. 65.

[2] *Rep. Macmillan Comm.* pp. 165–6.

[3] Report of meeting of Barrow Hematite Steel Company, *The Times*, July 1, 1933. The meetings of this company—now but a shadow of its former greatness—are always instructive.

[4] As a result the historical references of the Report are extremely misleading. Thus, e.g., the poor equipment of the industry for iron smelting was given a purely post-war explanation (p. 10) and the costliness of war-time extensions was remarked but not the Government contributions to the cost (p. 11). The redundant plant built *after* the war as a result of optimistic misjudgments was overlooked.

[5] This is suggested, very cautiously, in *Rep. I.D.A.C.* pp. 43–4, and *passim.* Below, p. 491, n. 7.

influence of bank pressure was lessened by the restoration of protection. The Sankey Committee had foreseen this—which no doubt explains its attachment to rapid scrapping. Several of its members, and most of its sympathisers in the "business world", would have looked askance at State compulsion. The May Committee did so too—willingly enough, perhaps, but in the circumstances it had no choice. "Not the least important of the developments which had taken place", it recorded in 1937, "was the acceptance by public opinion of a general oversight of the policy of the industry by an independent body looking to the public interest."[1] If for "public opinion" is read "influential opinion" the claim is well founded; and of course "opinion" was much more opposed to compulsion than to supervision.[2]

The May Committee was not in fact entirely averse from the use of coercion; like the Sankey Committee though not to the same extent it accepted the use of financial pressure,[3]—and, as a last resort, though not as a primary weapon, it would welcome State intervention. But in the main it relied upon the pressure of public and political opinion; the awareness of steelmakers that their political allies would be powerless to help them if monopoly were too obviously rampant; and the encouragement of a sense of duty and responsibility. For a time a rather unreal threat was maintained that the tariff might be withdrawn,[4] and

[1] *Rep. I.D.A.C.* p. 82.

[2] This is manifest in the *Final Report of the Balfour Committee* (1929), pp. 190–2 and 310–2. The misunderstanding of German rationalisation by British advocates of State planning is also brought out very clearly in the later passage; it helps to explain the subsequent ineffectiveness of their advocacy. My personal view is that "public opinion" was very malleable on this point, and could easily have been led. It is of course common knowledge that Liberal and Labour programmes had for long advocated supervision, if not socialisation. "*Britain's Industrial Future*,", p. 61, and "*What is wrong with the British Steel Industry?*" (Iron and Steel Trades Confederation, 1931). It is instructive to read this alongside the May Report.

[3] *Rep. I.D.A.C.* p. 41. "Where the Federation rejection of a scheme was endorsed by the independent body we feel little doubt that the result would be...to make it practically impossible to secure the necessary public support and financial facilities to proceed."

[4] The tariff was only declared permanent in 1934. At least one important scheme of reconstruction (at Cardiff) was held up until this declaration.

later the possibility of securing coercive power by legislation was mooted.[1] The Committee gave advice and criticism, sometimes it disapproved effectively; but it had no detailed plan and would have deemed a time-table impossible. Problems were tackled as they became publicly acute: physical reconstruction after Jarrow, price control when raw-material costs increased and prices were likely to rise. There were no illusions that this would produce quick results. "With an old-established and very complex industry which had developed over a long period of time and had until quite recently been very individualistic in its outlook progress in the new path was unlikely to be very rapid at first."[2]

Now manifestly the chief justification of the policy, admittedly slow in its effects, must be found in the operation of the organisation ultimately evolved. But there are signs, it is fair to remark before analysing the new structure, that the *costs* of its prolonged period of gestation were not fully appreciated. The stress laid by the Sankey Committee on the risk of malinvestment occurring, which would be a new obstacle to concentration and translation, had no counterpart in the May Report. Yet the earlier Committee had been substantially right. If marginal firms are enabled to reduce their costs and to increase reserves, though unable to become "low-cost" producers, they *do* become more difficult to eliminate. If by drastic action they go quickly, the waste involved in refurbishing them is patent. It may be less obvious, but it is equally true, that so long as they remain active they must tend to raise costs *throughout* the industry.[3] But it is not only the strengthening of marginal firms which may raise the general level of costs and delay radical change; the most prolonged effects necessarily come from the installation of new equipment which reduces costs sufficiently

[1] E.g. *Rep. I.D.A.C.* p. 82.

[2] *Ibid.* p. 13.

[3] Most directly, because, if the industry is not fully occupied, the more efficient firms will have heavier overhead or "on costs" per unit, and probably higher prime costs, than they would have if the inefficient were idle. More obscurely, because increases in the capacities of efficient units will be discouraged

to render its rapid displacement economically unjustifiable,[1] without achieving the degree of cost reduction which is most desirable from the national, if not from the firm's, standpoint.[2] And all improvement—whether on or off the "margin"—which postpones concentration or translation encourages investments in "social capital" and transport facilities which reflect and entrench the "unreformed" distribution of production both between and within districts.

The importance of these trends—of which there is ample evidence—was all the greater in these years since the general case for radical change was progressively strengthened by the course of events after 1931; above all because the relative costs of capital and labour changed in favour of the use of more capital. The fall in the rate of interest enabled firms once more to borrow extensively at from 4 to 4½ per cent, as in pre-war days; but the adjustment of sliding scales and the introduction of holidays with pay[3] increased the price of labour, irrespective of the fluctuations resulting from the operations of the scales. The effect of this changed relation was partly offset in the boom by the rise in the price of capital equipment;[4] but the change is likely to prove lasting and even become more pronounced. This naturally added new force to the arguments which persuaded the Sankey Committee in 1930–1 to advocate great capital expenditure for the concentration, integration and modernisation of production. The return of protection, also, strengthened the case for *radical* change—not merely expansion—since it altered not only the scale but also the character and the location of demand. More of the common-grade trades, best suited to mass-production

[1] The criterion for the replacement of plant as obsolete would be that *total* costs in the new plant should be less than *prime* costs in the old; but this is not as simple as it sounds.

[2] The outstanding example of this recently is, of course, Ebbw Vale; but it is a very "special" case.

[3] Cp. *Labour Gazette*, 1937–8, *passim*.

[4] Richard Thomas's reconstruction (excluding changes of plan) cost roughly 12 per cent more than was estimated; but some of the increase was due to unexpected difficulties, not to increased cost. The rise of cost was thus less than the fall in the cost of capital, assuming that interest and depreciation had fallen roughly from 12 to 10 per cent, both figures being possibly to high. (For data on the cost of the work, *The Times*, Jan. 26, 1937, and July 29, 1938.) Cp. below, p. 509.

techniques, became available for British firms; a larger proportion of the demand was now a home, especially a Midland, demand, so that the advantages of coastal sites were diminished and those of East Midland sites enhanced. More remotely the wider realisation in these years that population would fall also counselled concentration of production in fewer centres, though this was not of course a factor which had any immediate commercial manifestations.

There remains one final point. The early 'thirties were in many respects favourable for a "thorough" change. There was "surplus" steelmaking capacity, hence in raising the level of efficiency the duration of constructional works undertaken was a matter of little importance. You could afford the time to mature ambitious schemes, and the experimenting which new-style plant involved. By 1936 this was less true; urgent demand made it at any rate plausible to make changes which were quickly productive, changes which, taking a long view, were retrograde.

Here then is the debit side of the account. But it may be argued for the slow advance of reorganisation that there were items on the credit side too. First, it is possible that some errors were avoided. "Constantly changing conditions", the May Report declared, "made it impossible to lay down any precise lines of advance." And again, "Conditions may continue to change in the future as they have in the past, and possibly for some time with the same rapidity as in recent years; and it is obviously impossible at present to forecast them for any long distance ahead."[1] In 1931 the difficulties were greater than in 1937, since the data available for planning were much less adequate. For example, even the total demands for steel of the main consuming industries were wholly unknown, let alone the regional distribution of the demands for different categories of steel.[2]

[1] *Rep. I.D.A.C.* p. 42.

[2] The Federation thought the State must secure consumption figures: users of Continental steel would not wish to give data to the Federation. Now this has changed. The *Fifth Census of Production* (1935) published some data on consumption by industries, but they are incomplete.

Mistakes would have been made—and not only because of difficulties of forecasting.[1] But it is easy to exaggerate the fluidity of conditions, mainly because Britain had so much leeway to make up, but also because changes in the States and Germany were presumably sometimes designed to increase or sustain the bargaining power of firms, not to be directly profitable.[2] In retrospect it looks as though the planners of 1930, preoccupied by the existing firm-structure of the industry (as banks in particular are likely to be; and consulting engineers too, perhaps, if they are to get jobs) allowed for too little shift of location, and also grossly underestimated future demand.[3] In effect this second error would have had a healthy reaction on the first,[4] while the revival of demand in 1935–6 would have been in time to prevent the premature destruction of "surplus capacity". It is hard to follow the argument sometimes advanced that elaborate changes in the early 'thirties would have brought chaos in 1936–7;[5] and, though for reasons in some ways fortuitous, the mistakes which might have been committed in the name of planning were as nothing compared with those committed in a condition of State-aided freedom.[6] Assuming of course—as the May Report appears to—the essential soundness of the argument for concentration and "translation".[7]

[1] Above, p. 442.

[2] Above, e.g. p. 445. It is well known that even when 50 per cent of profits (which may be at a high rate on the initial investment) have been reinvested over long periods the return on the investment in a company has often not increased. The process that appears to occur is this: price-cutting is avoided, whether by formal agreement or not, so long as firms are more or less equally strong; but if one reduces its costs the others feel bound at once to get their prime costs down as well, for security. This "justifies" a very high rate of obsolescence, and therefore a high estimate of "capital costs". Neither prices nor profits take much benefit from technical improvement in these circumstances.

[3] The *P.E.P. Report* (1933) reckoned on about 8·5 million tons of ingot output.

[4] It would have allowed for an easy later growth in the relative importance of low-cost areas.

[5] A view not held at all universally in the industry. The more general view is: "had we only guessed what was coming we would have gone in for something big."

[6] The "planners" of 1930 would, for example, have avoided the return to Ebbw Vale and secured consolidation on the Tees.

[7] The Report served a double purpose. It was, as *The Times* put it, "a document of guidance" for the industry. But for the public a document of reassurance. With this in mind its remarks on technique and reorganisation are very close to those of

The second advantage which might be claimed for delay was the avoidance of a further aggravation of the problem of Depressed Areas. Translation, it may be said, is best left until a policy has been evolved for dealing with the social problems created in areas which industry evacuates. There is some force in this, as there is also in the kindred argument that the introduction of new methods should sometimes be delayed in order to lessen social dislocation. But whatever may be justified on these lines it is certainly not the creating of new obstacles to rational adjustment.

So much for the effects of delaying reorganisation. The present value of the structure ultimately evolved must not, of course, be measured by the costs of producing it. For all that, the transitional period is not merely of antiquarian interest, among other things because it defined once more, impressively, some of the complexities with which an effective organisation must deal.

For convenience of analysis the new system may be divided into three parts—the tariff, the machinery of price control, and the machinery for achieving efficiency, in particular by the supervision of investment.

The most clear-cut part of the system is the "effective flexible tariff". As handled in 1935 it had two objectives. Duties were raised as a negotiating weapon for British steelmakers, and then lowered again. This made possible on the one hand the virtual exclusion of foreign steel from the home trade; and the May Committee specifically defined the "optimum capacity" of the industry as one which "would meet the requirements of the country in so far as they can be reasonably anticipated",

its predecessors. "Certain matters of technical importance do stand out as requiring immediate consideration, such as the provision of more modern and larger Blast Furnaces and of additional basic Bessemer plant...." "The general tendency is to lower costs of production by increasing the size...of plants..." and "substantial advantages are gained in large-scale production" by integration. "In our view it will be necessary to take steps to secure the full advantages of modern plant developments and of planned production." "A great deal has been done in amalgamation...and in co-operative action but further progress under both heads is necessary." "We attach great importance to amalgamation in appropriate circumstances." These remarks (*Rep. I.D.A.C.* pp. 42–3) are embedded in others which soften the effect.

with a surplus for export.[1] But the policy also was a means of stabilising to some extent the proportion of available trade which British makers would obtain. In principle the second objective was far less vulnerable than the first; and the criteria upon which the ideal of self-sufficiency plus export capacity was based are obscure. In the contemporary setting the industry was expanding enough, without new exclusion of foreign steel, for the needs of defence, while foreign surplus capacity precluded any reasonable fear of famine for commercial consumers in the near future.[2] From a different standpoint, there was something to be said for conserving good mineral resources so long as foreign steel could be obtained cheaply;[3] all the more so since imports help the raw-material supply at home, by providing scrap. A slight increase of employment in the industry,[4] as a result of more exclusion, would moreover be a dubious gain if steel prices were to be kept for some time higher in consequence; and there certainly was a risk (though there were counter-balancing factors here[5]) that malinvestment encouraged by protection would become more extensive—unless the new policy brought the control of investment nearer.

With this prospect in mind, it seems possible that the policy of 1935 should be thought of as mainly diplomatic in conception. The extent to which it was likely to accentuate the harmful effects of the existing tariff was—most critics would allow—small. But the steelmakers, having been granted their extreme demands, could no longer plead that uncertainty due

[1] The point was further elaborated (*Rep. I.D.A.C.* p. 30): "Capacity should not be determined by a maximum possible demand, but should leave a margin to be filled by imports." This was to avoid the necessity of carrying a heavy burden of excess capacity. But unless it is possible to satisfy a greater proportion of home demands by imports in boom than in depression the degree of fluctuation cannot be lessened by relying on a "margin of imports", though its absolute quantity can.

[2] The fears of 1937 were hardly reasonable.

[3] Cp. Clapham, *op. cit.* III, p. 526. "A possible slackening of national demand for iron-ore might also be welcomed—though few either welcomed or discussed it."

[4] Cmd. 4851 (1935), p. 3.

[5] It could be seductively argued that any increase in the size of the market for British makers gave them more scope to use large-scale methods. But this was possibly a deceptive argument; if the large-scale methods came without concentration and "translation", short-period gains would be offset by long-period losses.

to foreign competition accounted for delay in reorganisation. Self-sufficiency, after all, could not be an irrevocable principle; and in the circumstances of the time its adoption, if it hastened "sound" reconstruction, was less objectionable in practice than in theory.

The second part of the new system—concerned with price fixing—is still in some respects obscure. The Federation, it has been seen, gave an assurance that "selling prices would be based upon ascertained costs", which superficially appears to provide a criterion of the "rightness" of prices. But it does nothing of the sort. What in fact is the relation of costs and prices? Whose costs—and for what output—are used (for costs vary from firm to firm, and most cost items do not vary in step with output)? And how are costs computed?

Only partial answers can be given to these questions. The cost information which firms supply to the Federation for this purpose is defined by a "Uniform Cost System"; it includes all costs save capital costs.[1] The information considered comes from "efficient and well-placed firms"—not from all firms; and the costs are estimated with due regard to the rates of output which seem probable at different price-levels during the period in which the prices to be fixed will be effective. From this information a "basic cost", as it may be called, is determined. This "basic cost" is *not* necessarily as high as the highest costs considered by the Federation (and afterwards by the May Committee); the number of firms whose costs are fully covered varies with the state of demand.[2] As indeed it must do, unless prices are quite commonly to rise as output falls. For prices are made by adding to the basic cost a uniform sum to cover interest,

[1] Mining and coking costs of an integrated firm are not included; market prices are accepted. The "Uniform Cost System" was worked out by a committee of the Industrial Research Council. *Rep. I.D.A.C.*, p. 50.

[2] The fullest references to these facts are contained in Mr Talbot's speech at the annual meeting of South Durham, *Times*, 15 Dec. 1938. According to him, prices for 1939 were based upon the costs of "a few selected works with certain economic and geographical advantages not possible to a large proportion of other makers". It is understood that by this date the *average* of the costs of the selected firms was adopted as the basic cost; the elasticity of the system therefore lay in the selecting of firms "reasonably placed for the class of trade concerned".

depreciation, obsolescence and profit—a sum said to be estimated on a stringent base, appropriate to the most up-to-date plant,[1] and assuming a normal rate of output, more or less mid-way between maximum and minimum activity.

Manifestly the system lacks the rigidity which is suggested when it is said that prices are to be "based upon ascertained costs" and freed from "the uncertain play of supply and demand". Prices are not in fact regarded as a precise function of costs (which in any case they could not be) and there is ample scope for taking account of the possible reactions of price upon demand. The system thus avoids any pretence that price fixing is scientific, it leaves room for experiment,[2] and it does not need to foster that negligent attitude towards costs which price control in the Great War encouraged.[3]

These are virtues. But the very elasticity of the system gives especial significance to the principles adopted in administering it. How do the Federation and the May Committee judge which firms at any particular time deserve to cover their costs? What are their estimates of capital costs? The criteria adopted in these matters are unknown. It is probably safe to assume that the payment of high dividends would be deemed objectionable—the majority of shareholders should have, perhaps, a steady 5 per cent. But there is no reason to regard a moderate dividend level as a proof that prices are "right".

There has indeed been constant criticism—much of it plainly irrelevant,[4] and some declamatory rather than analytical.[5] But

[1] At first sight this condition appears rather favourable to plants lacking labour-saving equipment.

[2] *Rep. I.D.A.C.* p. 48. The authorities emphasised the "importance of establishing gradually in the light of experience a sound and equitable basis...and avoiding the stereotyping of initial mistakes in a rigid system...".

[3] The system has been designed in this respect very deliberately, nor, it appears, without need, It is stated that administrative costs show a pronounced and not readily explained upward tendency. It is surprising—to digress—that though the evils of the system of "costs plus a percentage" were quite well known, they were not avoided at the outset in profit-control schemes instituted in other industries on account of rearmament.

[4] It was irrelevant to complain that users of Continental steel suffered; they were meant to.

[5] "A perfect ramp, an absolute ramp. Big cigars, and nothing to do." Lord Nuffield, after lunch, and reported in *The Times*, Aug. 22, 1937.

there was a serious suggestion, never very coherently expressed, that lower prices would not have prejudiced supply immediately and would have stimulated demand and lowered the future supply price. The first point was not in dispute; during the slump price-cutting occurred[1] but buyers found no difficulty in obtaining what they wanted. As to demand, the common view within the industry was that price reduction offered little increase of business; but the view was concerned with short-period prospects only, and the discussion revealed moreover a tendency to regard maximum net revenue—the monopolists' criterion—as a legitimate objective.[2] The third point was the crucial one. Put in another form it implied that current prices encouraged inefficiency. At first sight this is a persuasive argument; it is easy to recognise that throughout the post-tariff period the great majority of plants have found prices sufficiently satisfactory to encourage, and to help finance, renovations and extensions which fell far short of complete modernisation. But a lower price might have discouraged good as well as bad building; for it is hard, where few firms are efficient at all points, only to reward efficiency well: it expects too much insight of bankers and investors. For all that, the building policy associated with

[1] The extent is naturally not known precisely. The "coupled bargain" occurred: sometimes invoices were made out for less than the tonnage sold, sometimes cheques were not cashed. And there were more sophisticated methods. Above all, charges for certain finishing operations, e.g. straightening bars, were omitted, or very low. A few former "extras" are now as a result included in standard prices. Firms were more disposed, too, to poach in their rivals' home markets, despite gentlemen's agreements. A remarkable rise, between 1929–32, in the average receipts per ton of heavy steel carried on the railways may in part mark a growth of cross-freighting, though it also reflects declining imports and exports.

[2] The demand problem is referred to again later. It is very commonly argued in the industry that *if* lower prices would increase demand, efficient firms would refuse to accept high prices to suit the high-cost firms. Two obvious comments may be made. First, the efficient firms may prefer to make the maximum *immediate* net revenue—relying on the short-period inelasticity of demand rather than on an uncertain long-period elasticity. In the post-war world long-period guesses have been deservedly at a discount. Second, the action of the efficient firms would be such as to maximise their net revenue, taking advantage of quasi-monopolistic advantages. The price determined upon would tend to be higher than that which would induce the largest consumption consistent with continuous supply. The same comment applies to another argument, viz. that the capital value of plant in the industry is its earning power within the tariff.

the prices which were current before and during the boom certainly suggests that, as a guide for future policy, those prices may be regarded as having been too high.[1]

But recent experience also goes to show that price policy cannot effectively direct investment in the industry.[2] Raw-material conditions decree a big unavoidable gap between high-cost and low-cost production, hence a price satisfactory for the former will allow inefficiency in other areas;[3] while during a boom an unavoidably quicker pace of profit-making coincides with the discouragement of radical changes through rising costs of construction on the one hand, and the encouragement of patchwork changes, which are relatively cheap and likely to be completed in time to reap some benefit from the acute demand, on the other.[4]

Whether or not lowering the general level of steel prices (had it been possible[5]) would have had on balance a beneficial influence on reconstruction, it is certainly possible that a greater discrimination in favour of buyers of large quantities (taken in one delivery) of standard specification would have helped the advance of technique, and that the system of uniform delivered prices might with advantage have been modified. Greater discrimination was often advocated within the industry

[1] It will be recalled that the May Committee in 1935 anticipated that some prices would soon be reduced as a result of cost reduction, and were unfavourably impressed with the wide margin between high and low costs (above, p. 472). The most plausible defence of high prices is based upon the alleged need for very high depreciation allowances—which the May Committee is inclined to accept (*Rep. I.D.A.C.* p. 44). There is a risk that this may be exaggerated (above, p. 491).

[2] The May Report thinks otherwise (*Rep. I.D.A.C.* p. 51). It is of course possible to jolt the "marginal" firms—and I understand this has been done. Moreover, the possession of detailed cost analyses for price fixing would allow the Federation to discover and point out weaknesses in firms not on the margin.

[3] Prices presumably had to give a good return on Lancashire steelmaking which the Bank of England was likely for a time to make a touchstone of the profit-earning capacity of the trade.

[4] Diversification—if controlled and uncontrolled products are made side by side —and forward integration will also tend to lessen the effectiveness of price control as a means of directing investment. (Cp. above pp. 240–6.) They will also provide means of evading the spirit of price control while observing the letter.

[5] At the height of the boom it would hardly have been possible without central selling.

by those familiar on the technical side with the advantages of mass production,[1] and was suggested by consumers when the steelmakers complained of the continuing taste for fancy steels.[2] The small steel firms probably resisted the proposal; for though it would reduce their costs it would tend to remove their *raison d'être*. With regard to the second point, it is now almost a matter of indifference to individual consumers how far away they are from steelmaking, so long as they are not in high-price regions such as Aberdeen.[3] But it is not a matter of indifference to steelmakers, or to steel users collectively; and it might well be advantageous either to have uniform prices *at works* (or at a few basing points), or, more radically, to have basing-point prices not uniform, but reflecting in a measure the variations of cost from district to district. After an initial period of disturbance there would probably be a net gain to the industry—and industry as a whole, though not to all firms or all users individually. Thus, for example, it would be an important advantage if the less radical change brought more sheet-using industries near to the sheet-producing plants, or concentrated more billet consumption near Sheffield. Anomalies in the industry, the fruits often of imperfect competition which are hardly worth preserving under a system of controlled prices, could be lessened by this process as a complement and alternative to moving steel production.[4] The more radical policy would attract consumers not merely to steelmaking but to low-cost production. On all these problems the May Committee took no line in its Report, though it referred to them.[5]

[1] I have found the technical side of the industry more interested in the point than the commercial, but it may have been a matter of chance.

[2] *Rep. I.D.A.C.* p. 47 refers to the attitude of the Society of Motor Manufacturers on the point. The references are non-commital with regard to discrimination, but strongly in favour of standardisation. It points out that though the rolls in heavy mills can produce from 800 to 1200 tons without being "dressed" the normal rolling, before a pair of rolls is changed, is only 200 tons: *ibid.* p. 46.

[3] Above, pp. 377–80.

[4] The process is easier with protection. When foreign steel came in freely many points not very close to British steelmaking centres were well placed for Continental supplies. London is a case in point: accessibility to Continental steel supplies has no doubt encouraged the industrial expansion of this area.

[5] For the uniform price problem, *Rep. I.D.A.C.* p. 50: "A uniform national price

There remains to be considered the second of the twin principles of Federation price policy—the principle of stabilisation. Broadly speaking it implies that the industry should make monopoly profits in a depression and monopoly losses[1] in a boom. Prices should be held more or less rigid; moving perhaps, in the long run, in harmony with any movement in the general level of the prices of "all industrial products".[2] Now although the principle has been often referred to, it has not been applied, and it can only be discussed in general terms. The Federation, it is true, had it in mind when it deliberately moderated the effect of marginal costs in 1937; but those costs did not remain for long at their maximum,[3] and the net effect of the price policy followed[4] can hardly have been to reduce the revenue of the industry over the whole high-price period appreciably if at all below the "competitive" level. Actually the rise of prices between 1932 and 1937–8 was hardly less intense than those which occurred between slumps and booms in pre-war days; and while it is true that expansion was greater, this must be set against the fact that prices were much more rigid after 1929 than in pre-war

has definite advantages both to the producer and consumer. It facilitates the working of an association arrangement for price control" (but German and American controlled prices have always been basing-point prices) "tends to greater price stability than if each district had separate prices, and enables the consuming industries to locate their works by reference solely to their markets." (Why should they?) "But it can only be justified if there is no serious disparity between the costs of production in different areas and, so far as delivery charges are concerned, if it does not lead to too wide a dispersion of consuming industries."

[1] I.e. profits would be less than in a state of competition.

[2] With this qualification, that if the efficiency of making steel increased more or less than the efficiency of making "industrial products" in general then the price indices should not move in perfect harmony. Between 1930 and 1935 the *Census of Production* shows an increased "physical output per operative" of 27 per cent in "all industry", of 14 per cent in iron and steel (G. L. Schwarz and E. C. Rhodes, *Output, Employment and Wages in the U.K.* 1924, 1930, 1935, p. 35). Prices diverged rather more acutely: they are graphed in *Econ.* Oct. 22, 1938, p. 172.

[3] Cp. *The Times* (City Notes), Sept. 12, 1938. Coke prices fell 5*s.* a ton in February and again in May. Coking coal fell less, but had risen less. New contracts for foreign ore were placed at much lower prices in the spring, and freights fell; the *average value* (Customs) was kept up by old contracts. Home scrap prices fell in the summer. Little scrap or pig iron was imported after June, but the "spread-over" spread the burden over the year.

[4] A policy of infrequent change—but *not* of stability.

slumps. The boom prices were clearly no basis for stabilisation; and the boom history suggested, too, that stabilisation was impossible unless the industry was willing to incur more "monopoly losses" and to prepare more effectively for working at peak capacity by the accumulation of stocks of pig iron (and perhaps scrap).[1]

But if it be presumed that the "right" general level of prices *can* be, though it has not been, found, then the argument for stabilisation is persuasive. Some claims made for it in the past —for it is a traditional Kartell ideal—that it would be a potent weapon for moderating the trade-cycle are patently exaggerated, and in recent discussions less has been done to show the positive advantages of stabilisation than to undermine the arguments which extol the virtues of great fluctuations.[2] Within its more modest limits the case is interesting.

Two positive advantages are emphasised. (1) The encouragement of rash extensions in booms can be lessened; but this can probably be done better in other ways. (2) The withholding of orders in anticipation of price falls and the piling up of orders in anticipation of rises could be avoided. This is rather a case against many and small changes than against any change. The negative case—against violent fluctuation—centres on the inelasticity, in the short period, of demand for capital goods (for which steel is mainly required). This demand is derived from the demand for consumption goods, but for reasons now largely familiar it necessarily oscillates much more violently. Now a possible reduction in the prices of capital goods would affect prices, and therefore prospects, in consumption-goods industries so little (if at all) that, in the short run, it could not affect appreciably the amount of new equipment—whether for replacing worn-out plant or expanding capacity—whose installation those prospects justified. This greatly weakens the argument

[1] The choice would depend on the relative costs of increasing the supplies of scrap and pig iron, and their relative "storable-ness". The scope for storing scrap is clearly more limited than the scope for storing pig iron.

[2] There was a good statement of the case in *The Times, Iron and Steel Number,* June 14, 1938, p. xvi.

that reduction of steel prices would be a spur to revival of trade in a depression, and it is hard to sustain the view that, in any serious degree, the more price is stabilised the more output must fluctuate, save where there are substitutes for steel, or where foreign steel goods may displace British, or where low prices might stimulate buying for stock, or where steel is used for consumption goods. These are not insignificant exceptions, and the first two rule out the prospect of universal stabilisation throughout the trade. A policy of price discrimination could be adopted, however—to be followed, no doubt, by negotiations for "spheres of influence".[1] With regard to stocks, the big firms or the industry collectively might replace the speculative merchant.[2] Recent experience has shown that this problem is important. The second element in the negative case—*against* violent fluctuation—derives from the first. If demand for new steel is

[1] For discrimination in export trades, above, p. 481. It is suggested that the significance of substitutes and of foreign prices has been insufficiently recognised by the industry recently (*Econ.* Oct. 22, 1938, pp. 172–3), and that the elasticity of demand has been underestimated. Certainly substitutes (e.g. ferro-concrete, non-ferrous alloys, and synthetic resins) are now competing over a wider range; and British home prices since 1937 have compared less favourably with foreign home prices than in the period 1932–6. In that period open-hearth steel was cheaper in Britain than in France or Germany (but not Belgium), though where Thomas steel would do steel was dearer, and former users of Continental steel in England suffered. The position of the 'twenties (above, p. 427) had been reversed by the depreciation of sterling. In export trade this did not prove significant, owing to the broadening of Continental export discriminations, associated with rebate schemes to assist makers of exported finished goods. Since 1936 the rise of British home prices outdistanced similar movements in competing centres. The *Economist* regarded this as helping the growth of foreign at the expense of British shipbuilding. Growing competition helped to induce the price reduction of 1939 (above, p. 454) which several makers opposed.

[2] Speculative holding of pig iron used to be important, but speculative holding of steel has probably never been so. Steel was bought "forward" when prices were low but, details being unspecified, could not be made in advance. Accumulation of stocks of pig iron has recently been advocated in the industry. Mr Frater Taylor thought the State should buy pig iron in preparation for war, since smelters would otherwise have to blow out furnaces (*The Times*, May 31, 1938); and Sir Walter Benton Jones thought the steel industry should keep stocks against a boom, and so avoid purchases at exorbitant prices (*ibid.* Oct. 15, 1938). Although steel is less adapted to "stocking" than pig iron, the scope for doing so could probably be surveyed with advantage. Merchants who are stockholders have had a rebate in purchases since 1936, but it is insufficient to encourage long-period stocking (*Rep. I.D.A.C.* p. 65).

inelastic in the short run it is doubtful whether rigidity of steel prices in a depression would accentuate the fall of other prices. Indeed, price maintenance may sustain the volume of investment and thereby lessen the other falls. The third negative point is that low prices cannot be relied upon in the present competitive conditions to raise the level of efficiency in the industry by eliminating inefficient firms through bankruptcy. Of course the more the force of this argument is recognised, and the more it is accepted as a reason for not *trying* to achieve efficiency by driving some firms bankrupt, the more vital it becomes to seek other methods of ensuring efficiency.

While stabilisation is yet to be seen in practice, some of the steps already taken by the industry to moderate fluctuations are of considerable economic significance. The linking of the price of coke sold to the industry with the price of steel by a sliding-scale arrangement extending over several years is one of these. Stable prices for coke can hardly be advocated on the same grounds as for steel, while the device in question, in ostensibly relating costs and prices in steelmaking, rules out this policy for coke making. Manifestly the sliding scales will need frequent adjustment, if only to make price control effective. The fact that some steelmakers buy a lot and some a little coke will help to ensure the satisfactory working of this scheme. The proposed scale, it may be added, is rather ominous in its details.[1] The second stabilising step whose consequences are worth examining may prove to have been a mere emergency measure—it was the policy of keeping down the price of scrap and pig iron by neutralising the effect of costly importations. This policy had the effect of discriminating between different firms and different districts. It was inequitable that firms which had bought supplies of materials (whether mines or stock) which would enable them to work at full capacity in the boom without great increases of cost, and still more that firms actually burdened with heavily increased charges for imported ore, should have

[1] The sliding rate is such that if steel prices fell to their 1929 level coke prices would fall much below their level in that year; they would, indeed, be close to their level in 1933.

been called upon to help firms less prudently (or, as it might seem, imprudently) integrated or otherwise secured. The inequity was defended and tolerated on grounds of national interest; nevertheless the diversion of profit it involved, if it were recurrent, would add yet another to the many irrational influences on structure and location.[1]

Recent price history confirms the view, long accepted by most economists, that the task of "countering the bias of private interest" by price control "cannot be carried through completely".[2] The interest of the new organisation of the steel industry lies mainly therefore in the working of the mechanism which it contains for supervising and directing investment, for shaping the physical reconstruction of the industry: a task of especial subtlety and significance in view of the leeway to be made up.

The system of examining—and if need be instituting—plans for expansion, which has been described earlier,[3] did not constitute the complete mechanism which the Federation and the May Committee had in mind for handling the investment problem. An additional weapon was designed, though it is not yet forged, namely the control of "quotas". The "examination" system must be discussed with this supplement in mind.

"Quota schemes"[4] have been contemplated from the start in the planning of reorganisation. But for the flux of competitive strengths caused by protection, growing markets and unwonted renewals of plant, a universal system of quotas would now be associated with the fixing of prices,[5] and competitive selling would probably have begun to give way to some form of central selling in most branches of the trade.[6] It is likely that immediate

[1] The May Committee has pointed this out: *Rep. I.D.A.C.* p. 51.

[2] Pigou, *Economics of Welfare*, p. 381. [3] Above, p. 462.

[4] I.e. schemes whereby a definite quota or proportion of the trade in a particular commodity is allocated to each participating firm.

[5] Quota systems now obtain in the tinplate, sheet and wire trades; in the heavy trades they are lacking, though there are informal agreements. Informal agreements are not of course satisfactory when there are many competitors, as there are in the light trades: *Rep. I.D.A.C.* pp. 57–8.

[6] Central selling had the approval of the May Committee: *Rep. I.D.A.C.* pp. 65–7. But there is not complete unanimity of opinion in the industry.

economies would have resulted therefrom through the elimination of roll-changes and cross-freights.[1] But there was a danger. "The dynamic stability of smooth and ordered progress" which quotas were to bring might, in the words of the May Committee, degenerate into the "static stability of stagnation".[2] To meet this danger the Committee had secured a number of assurances from the Federation. New-comers were not to be debarred from the industry, though they could not enter unconditionally; the operation of the quota system was to be supervised by an "impartial body", and—most important of all in this context—quota schemes must "not impose a prohibitive penalty on initiative and enterprise", but should "make special provision for maintaining the most efficient plants on an economic basis of production during periods of depression". Now quite clearly such a system of ensuring good quotas to efficient plants could be an extremely potent influence on investment. But when the May Report was issued there was "not yet a fully worked-out policy"; nor was there a year later, to all appearances.[3] The only clue to the actual system projected lies in the statement that the Federation might use its Stabilisation Fund, among other things, to "maintain on a 'care and maintenance basis' in less busy periods plants which might well be necessary to meet peak demands".[4] Presumably plants which were "rested" would not be "improved". How many of them will there be, and how will they be chosen? Unless the policy were drastic it would have little effect. But it would surprise firms which elaborately "improved" between 1932 and 1938—as most did—to find that, after all, their plants were to be treated as reserves. The

[1] Mr Bosanquet of Skinningrove claimed that 8*s*. a ton could be saved in rolling steel bars. Possibly this was only likely in a depression, when firms were living from hand to mouth, and did not always know in the morning—so it is said—what they were going to roll in the afternoon. *The Times*, Aug. 20, 1933.

[2] *Rep. I.D.A.C.* p. 59.

[3] In May 1938 a director of an important firm confirmed this view with the remark "There is no plan for demobilising the industry."

[4] *Ibid.* pp. 20, 58. Presumably a firm would receive compensation equal to the gross profit anticipated if it retained its quota. As expansion occurred elsewhere 'rested" plants would presumably be "scrapped". On what terms?

prospects of an early change of any significance are certainly not bright.[1]

But they must for all that be remembered in considering the most conspicuous weakness of the "examination" system, namely its failure to embrace *all* expansion.[2] Some of the unco-ordinated changes which occurred in the boom were of the kind which would now have to be submitted for examination; the period was thus not representative. Nevertheless it is hard to see how there can be "wise planning"[3] if minor schemes of expansion, and changes which do not involve expansion, lie outside the examiners' ken; all the more so since concentration and "translation" are among the chief needs of the industry. The scattered and ubiquitous improvement which is in England a token of imperfect competition would go on, building up cumulatively a formidable obstacle to radical cost reduction—unless it were disturbed, as it would be, by a policy of enterprising quota control. Reluctance to undertake the supervision of virtually all investment in the industry would be comprehensible. But a policy of "resting" plants, effectively administered, would in fact involve the same kind of judgment.

The plans submitted within the first two years for examination under the procedure instituted in 1936[4] were few in number. But they were, so it happened, more instructive than numerous. For three of them involved the crucial problem of the industry's reconstruction, that of location. The problem was delicate. It would be stupid, if it were possible, to centre all production where production is now cheapest; to do so would involve a costly transfer whose benefits would in a relatively short time be exhausted. To promote long-period stability there must be some relatively high-cost production using foreign ores; costs cannot all come down to the Corby level. The proportion in which the

[1] *Rep. I.D.A.C.* p. 60. Quota policy "can only be developed gradually in the light of experience". In July 1939 Barrow agreed to transfer its heavy steelmaking to Colville's, who were to purchase most of Barrow's pig iron.

[2] "It would be necessary to define what measure of increased production would constitute 'expansion'...since practically all renewals of plant...give a greater output" (Federation resolution, in *Rep. I.D.A.C.* p. 36.

[3] *Ibid.* p. 31.

[4] Above, p. 464.

cheap and dear resources are to be used obviously affects very much the planning of future location. But whatever the proportion, it seems reasonable to suppose that in "wise planning", such as the May Committee commends, such raw materials as are used (including scrap) shall be used where their assembly in the quantities required for economic conversion, together with the delivery of the final product to market, is cheapest. The delivery costs influence the situation little,[1] since a market is commonly a source of scrap in proportion to its significance as a consuming centre, while the scattered occurrence of coal in Britain leaves no important market far from one of the sources of raw materials. Moreover markets are not, like mineral deposits, immoveable. Material assembling costs are thus the chief consideration. Now while the technical changes involved in the major expansions sanctioned in 1936 were impressive, the schemes scarcely reflected any advance towards a well devised ground-plan for the British industry; indeed two of them positively stood in the way of such advance. The explanation of this may provide the key to the early future of planning in the new dispensation.

Some of the determining influences were of merely immediate significance, characteristic of a transition. The desire to avoid disturbing production during the boom, for example, was an influence on the Clyde, which should prove non-recurrent.[2] It is likely, too, that though planning had been for long debated, the "Examiners" had not worked out a plan of their own in these early days, either individually or collectively. Within the industry the incentive to supervision had been the desire to avoid "over-capacity", not a desire to minimise costs. Finally the May Committee possibly viewed with satisfaction the mere voluntary acceptance of supervision both from within and without, as a token of that decline of individualism to which it probably attached the wrong significance.[3] In all the chief

[1] This is, in a sense, accidental; for delivery costs affect comparative costs a lot.

[2] *Rep. I.D.A.C.* p. 38. "There would be much disturbance of production at a time when it would cause a maximum of inconvenience" if any plant were moved to a new site farther down the Clyde.

[3] *Rep. I.D.A.C.* p. 12.

producing centres in these years—in Germany, France, Belgium and the States—makers welcomed restrictions upon the building of new plant, nor is it hard to see why.[1]

But there were other factors which deserve closer observation: in particular, the reliance upon the initiative of firms. All the major changes sanctioned before the May Committee reported (and, for that matter, since) were proposed by existing firms. The Federation recognised a duty actively to initiate proposals for expansion "in sections of the trade where that might be necessary...to preserve a full balance of productive capacity or to ensure highest efficiency";[2] i.e. where the initiative of firms conspicuously failed. But there was no question of a general plan,[3] and it was probably right to regard the Federation's initiative as a reserve force, to be used in extreme cases.[4] Certainly there was a marked unwillingness to interfere with the integrity and autonomy of existing firms, even where this seemed necessary for maximum technical efficiency.[5] The May Committee specifically repudiated the policy of compulsory amalgamation. "We are satisfied that the full benefits (of amalgamation) only accrue when it represents a natural alliance based on community of interest."[6] (One wonders whether

[1] For Germany, above, p. 446. Under the Nazi régime the State implemented by law restrictions self-imposed in the first instance; and later adopted a policy of "ordering" desired investment (notably in oil-from-coal plants), while it also—as seen earlier—set up plants of its own. In the States restriction on plant building was part of the N.R.A. scheme. It was welcomed by the makers, whose distaste of N.R.A. was, so it is said, limited largely to a fear that State intervention *might* become more enterprising. Once there was some recovery competitive building recurred, and competitive price-cutting came when trade again slumped. In France makers agreed, as in Germany, not to enter new trades till the Comptoirs were renewed (and quotas readjusted). In Belgium, by a decree of January 1935, no new works were to be put up without permit, and independent concerns had to conform to the policy of any syndicate embracing 75 per cent of its trade. In France this policy of compulsion was mooted, but proved unnecessary.

[2] *Rep. I.D.A.C.* p. 36.

[3] "Constantly changing conditions make it impossible to lay down any precise lines of advance." *Ibid.* p. 42.

[4] The duty of reviewing capacity and taking initiative was delegated to the Emergency Committee. *Ibid. loc. cit.*

[5] It will be recognised that only the *predominant* view can be identified here. It is not impossible that minorities advocate different views; and the minority view may one day predominate.

[6] The argument is commonly supported by reference to those amalgamations

they would allow expansions by each of two rival firms in circumstances where they thought the best results would be achieved after fusion.) In approaching the general problem of securing the optimum scale of plants—manifestly larger than the normal existing scale[1]—the Committee emphasised that changes must be made "with due regard to the interests of the individual firms comprising the industry", a cryptic phrase not further amplified.[2] There are signs of a disposition not to reject the proposals of a firm merely because they fail to make the most of the opportunity of change, so long as the firm regards them as competitively sound from its own standpoint. "Location A is not the *best* site for a new plant", it will be argued, "but it is better than (or no worse than) location B, where an important competitor produces."[3]

The losses involved here are clearly judged to be small beside the gains which, it is thought, accrue: the encouragement of individual and varied initiative, the maintenance of some forms of competition, the avoidance of complete integration, of State investment, State guarantees, or a State-appointed management. But it is open to question whether in setting out the comparison the degree of possible divergence between the interests of firms and the national interest has been realised to the full; there are strong grounds for the view expressed forcibly by *The Times* in 1937 that, given the present system of price control, the oversight exercised in matters of investment in the industry "must be directive".[4]

In the first place, since radical reduction of costs in a plant is likely to bring down home prices through the operation of price

whose conflicting internal interests have prevented satisfactory development (above, p. 249). But the more obvious conclusion from this evidence is that *voluntariness* is not enough.

[1] I am told that the governing factor should usually be the optimum capacity of an efficient blooming mill, which would be roughly between 5–600,000 tons a year working two shifts a day, 750,000 tons working three.

[2] *Rep. I.D.A.C.* p. 43. The idea was canvassed in the industry that a levy should be imposed on new low-cost plants to pension off high-cost ones. A more popular idea favours a levy on *all* production.

[3] I have met this argument more than once.

[4] Quoted above, p. 466.

control, the return on new large-scale investment is never likely to be high, while for a firm with many plants a radical change in one will reduce the remuneration derived from the others. Thus the zeal of directors for cost reduction must be relied upon to stimulate radical change rather than the zeal of investors for profits;[1] and while this has worked effectively in some countries it is not in the English tradition, nor has it invariably led to economic efficiency.[2] In the second place, it is quite obvious that those concerned in running a firm or plant have a material interest in continuing its existence, and avoiding changes which unfavourably affect either their status or their income.[3] Thus one plan may well be preferred to another if, by requiring much less capital outlay, it avoids a transfer of financial power. A bias of this kind will be most potent where the data upon which decisions must be founded are not precisely measurable. Decisions about investment depend among other things upon forecasts of the rates of depreciation and obsolescence, which may easily be exaggerated.[4] Such exaggeration of course has the paradoxical effect of checking investment. In the third place, the character of the equipment used, the burden of administrative detail and the exigencies of competitive tactics are all likely to foster investment which is short-sighted from a

[1] When export trade is in question of course the lowering of costs does always increase profits; but in the home trade this is not so, if prices fall, save where demand is fairly elastic. It will be observed that though a change whereby total costs in a new plant are below the prime costs in the plant to be replaced is always nationally advantageous, it is not necessarily so to the firm making the change if prices are automatically lowered.

[2] Above, pp. 340–1, 444–6, 490.

[3] It is notorious that considerations of this kind have proved obstacles to amalgamations, and have robbed some amalgamations of some of their advantages.

[4] It may be reckoned that the average life of all parts of a wholly new plant will be from 20 to 25 years. The *cost* of an integrated plant, including coke ovens, to roll bars and small sections, would be roughly £18 per ton of product (in 1939; in 1934 it was about £14). Some parts of a plant wear out so quickly that their maintenance is a prime cost (e.g. furnace linings); others have a life much above 25 years (e.g. water supply installations, buildings, and—if well chosen—the site). Parts, again, have a life of only 10–12 years—e.g. the turbo-generators. The rate of depreciation on patches is higher than for new plants, since the parts most commonly replaced are those which wear out fastest, and an old plant has a shorter expectation of life than a new one. As a result of this, radical change is likely to be more sensitive to change in the rate of interest than investment for patching.

national standpoint. The equipment lends itself to patchwork modification. And since different parts of a plant do not have the same "life", as one portion after another successively wears out it is tempting, and often right, to replace it—usually with improvements and increased capacity.[1] And this process of serialised replacements within plants acquires a momentum which it is difficult to resist. Radical change calls for special effort, courage and inquiry; its results cannot be gauged from day-to-day experience; it may require negotiations with other firms; there may thus be obstacles outside an individual firm's control; and since the traditional policy dissipates depreciation funds, there may be difficulties in arranging finance.[2] Meanwhile boom conditions may invite a change which can be quickly wrought, the state of part of the plant may force quick decisions, and it may be dangerous in competition to forgo minor improvements and expansions, even to accumulate resources, when rival firms do not do the same. Finally, firms may be reluctant to move to a new site simply because they are unwilling to bear the responsibility of aggravating unemployment in an existing centre of production.[3]

It is sometimes thought possible to harmonise the interests of

[1] This is one of the factors which gives rise to the popular view that the pioneer centre of an industry labours under an insuperable disadvantage and can never be the best equipped centre. Actually, of course, so long as raw materials are available, the older a centre is, the more worn out and out-of-date its plant, the more ripe it is economically for thorough re-equipment; and if this is held up it is most likely to be an outcome of the structural rigidities which flourish in old centres.

[2] Even a firm which had conserved resources might find the financial problem complex. John Summers' financing of the Shotton strip mill is a case in point. A large sum of new capital was secured from the United Steel Company, and the Bankers' Industrial Development Company procured the rest. John Summers agreed to the setting up (for up to 10 years) of a supervisory committee consisting of the Governor of the Bank of England, the Chairman of United Steel and their own Chairman. No step was to be taken without the agreement of the Chairman of United Steel so long as his Company had a substantial investment. The shares subscribed through the medium of the B.I.D. were to be available for a period of 7 years at most, on terms which ensured reimbursement of capital, and interest, but no capital profit. *I.C.T.R.*, Jan. 13, 1939, p. 70. Prior to the publication of this plan United Steels floated £880,000 new £1 shares at par.

[3] Actually the industry collectively responds to this feeling; probably all concerned are disposed to delay radical shifts of location until the State has grappled effectively with the Special Area problem.

firms and of the nation by administrative devices which modify the former. Something of the kind may indeed have been tried.[1] But it is unlikely that this can have sufficient effect, and as the disharmony is more clearly perceived central planning of investment will no doubt advance. Such machinery as exists for this has not so far yielded any positive, or at any rate public, results—there have been committees to examine the two topics singled out for consideration by the May Report[2]—and until this creative and stimulative part of the new organisation has been seen at work its quality naturally cannot be judged. At a first glance it contains obvious anomalies. In view of the conflict of interests which has just been surveyed it is odd that planning rests primarily in the hands of a body composed, with one exception, of the representatives of firms.[3] It may be easy of course to make too much of this. The interests of different firms represented on a committee will to some extent cancel out. The heads of companies, often salary earners with a small formal investment only, interested in the conduct of other firms and the success of other industries, will not always have an undiluted concern for the profits of a single company. Moreover the virtue of a structure of this kind depends much on the persons to whom it gives power. Nevertheless planning will certainly strain the loyalties of some of the planners.[4] It may also require more time than can be found by men who are already responsible for running a large firm, or conducting Federation

[1] E.g. it has been argued that to keep scrap prices low, as by the spread-over scheme, pressure is put upon iron smelters to lower their costs.

[2] The scope for more up-to-date blast furnaces and for more Basic-Bessemer steelmaking. *Rep. I.D.A.C.* p. 42. With regard to the second of these it is now, I believe, generally agreed that where the cost of pig iron falls below a certain limit, as it does in certain areas in England, the Thomas is the cheapest process, and the further advance of the process is presumably only a matter of time.

[3] The Independent Chairman was of course appointed to offset the particular interests of the representatives of firms.

[4] This would be in some degree true if the planners were trade-unionists. Planning was sooner and more warmly welcomed by the Unions than by the Federation. But the Trade Union statement of policy (*What is wrong with the British Steel Industry*) did not lay stress upon the need for change of location, though emphasising quite properly the need to mitigate the social dislocations caused by it.

business with regard to prices, raw materials, and the like, or administering the Tariff. The May Committee was hopeful of the new organisation partly because so much had been accomplished despite "the present heavy and urgent demands upon those engaged in the conduct of the individual concerns".[1] But a time of great activity is not the time when the central authorities should be, as they will be, most distracted. Strategy is in danger of being relegated to second place. Manifestly, too, planning in its broader aspects requires different aptitudes and knowledge from the conduct of an individual competitive business, where the political and administrative arts of managing buyers, rivals and staff, and short-period forecasting, are perhaps of most consequence. But here again there is a risk of over-emphasis; for the planners will have the assistance of the Federation's permanent staff.

Apart from these matters of personnel it is easy to see that the "wise planning" of steelmaking, from a national standpoint, cannot be perfectly achieved by the steel industry acting in isolation. This is a weakness of organisation which those who framed the new structure could not avoid, but it is not for that reason to be overlooked. If the disasters of the past—the creation of industrial centres relying precariously on one or two staple trades for which raw materials promise a relatively short life—are to be avoided, without a merely negative policy, then the actions of several industries must be concerted. Moreover, there are two influences likely to disturb the planning of location which the industry cannot properly discount, which only the State can eliminate, and of which one is the creation of the State. There is first the subsidising of unsuitable sites by remissions of local or central taxation[2] and the like; and second the manipulation of transport rates for competitive purposes—to

[1] *Rep. I.D.A.C.* p. 82.

[2] Cp. e.g. White Paper on *Special Areas*, printed in full in *The Times*, March 2, 1937. The Blackburn Council protested to the Government that "concessions in the matter of rates, and charges for gas, electricity and water are being offered by some towns", which was "not only unjust but of doubtful legality": *Manchester Guardian*, Nov. 12, 1938.

help one railway against another or to check the revival of canals.[1] (Obviously with the growing importance of the Midlands as a source both of ore and steel the canal might properly come into its own again; but the unfavourable interests are strong.[2]) The problem appears to be significant; it is said, for example, that in regard to one works concessions made by taxing authorities and railways together reduced the cost of producing steel by 5 per cent.

The motives behind this sort of thing are a curious blend of the compassionate and the commercial. The results seem likely to be unsatisfactory, since transition is delayed and even prevented by a process which masks the real costs of production and tends to maintain "real" prime and capital costs at an avoidably high level. A subsidy which helped an area to meet the short-period discomforts of a desirable transition or to overcome a merely temporary misfortune, would clearly be defensible. And from a liberal standpoint a subsidy would be justified whose burden was borne wholly by the locality concerned, expressing a preference for the old locality and relative poverty rather than a new locality and greater material wealth; but this does not in fact occur. In general, of course, tax concessions, when they are not part of a hand-to-mouth policy, are more likely to be well judged than railway concessions, whose competitive bias is hard to reconcile with a radical and rational shifting of the channels of trade.[3] Distorting influences of this kind lie obviously outside the control of the new planning organ of the steel industry; though the industry

[1] Competitive railway rate policies are not usually "cried from the roof tops". But no attempt is made to hide the competitive policy. See, e.g. the Chairman's speech at the G.W.R. meeting, *The Times*, Feb. 27, 1936. "I have no doubt that our new director" (Sir Charles Wright, of Baldwin's) "will do his utmost to secure at least as high a percentage of the steel production as we had in 1929."

[2] Among other suggestions which have been made is one to build a ship cana from the Northamptonshire ore field to the sea; this area might also be linked by water with the existing West Midland canal system.

[3] Tax concessions might, e.g., be used as a means of procuring a distribution of production which was adjusted to the needs of war without imposing the burden solely on steel users. Strategic considerations, in fact, appear to have had no part in determining location so far.

might presumably appeal to the Railway Rates Tribunal, as the May Committee suggests should be done with regard to the claim that the iron and steel traffics on the railways contribute an unduly high percentage to the total railway revenues.[1]

In a concluding passage of its Report the May Committee allowed that the objects which it had in view might only be attained "if the Federation and the independent body...were provided with statutory power". But it hoped to avoid this, being encouraged by the growing support given by the industry to the new experiment while reorganisation remained voluntary. This judgment is important. It would be more satisfying however if the criteria of economic efficiency which the Committee adopted in making it, and which it will adopt when it reviews the conduct of the industry in the light of the important undertakings given from time to time by the Federation, were made clear. It is not enough that a supervisory body should be impartial; nor should its judgments be merely intuitive. The one criterion adopted which seems quite clear—the principle of national self-sufficiency—is scarcely reassuring. So far, the policy followed by the industry can hardly be said to differ *in character* from the policy which any Kartell might be expected to follow in similar circumstances, save inasmuch as it has placed itself under specific obligations to the State. The institutional expression of public opinion may have produced some difference *of degree*. But a monopoly in the public eye will usually make concessions to avoid criticism. It is good politics. Judge Gary, it will be recalled, would have welcomed the fixing of "fair and reasonable" prices by the State, and it was his policy "to change any practice whenever it was seriously complained of by governmental representatives".[2] The advance of co-operative activity in the industry, which the May Committee finds impressive, but

[1] But in all probability an appeal on the subject of "special rates" and the like, even if the firms in the Federation who are beneficiaries would tolerate it, would fail, since revision would involve a reconsideration of the basis on which rates are now calculated. For the May Committee and the highness of *all* rates, *Rep. I.D.A.C.* p. 62.

[2] Tarbell, *op. cit.* pp. 232, 317. Miss Tarbell thought (in 1925) that Gary had gone far to substitute balance for instability in American industry.

which is not a surprising outcome of depression and protection, has not got far beyond the point at which, while it may be of advantage to consumers, it is of advantage to all producers individually.[1] Dividends, it is true, have not been for the most part high; but the serious risk in the British industry, it has been seen, was that capital values would be maintained at too high a level. The case for greater efforts to increase efficiency will certainly be pressed in the Federation. But the vital concessions, which would involve a serious sacrifice on the part of existing interests, have yet to be made. Meanwhile, if the Sankey Report was at all a good guide, the way to maximum efficiency is more and more cluttered up with compromises, which to the unwary count for ordered progress. Hence, even if ultimately successful, a prolonged constitutional experiment, which is to discover by a course of homoeopathic doses the minimum of State stimulation, suggestion, or coercion necessary to "counter the bias of private interest" in the industry, may prove an expensive luxury. Indeed, since the principle of State control is conceded, it may savour in retrospect of those "obscurantist methods and lethargy" in economic politics which a distinguished architect has recently lamented in another not dissimilar context.[2] It would not be surprising if in the near future the growth of competition—from foreign producers in export markets, and from possible substitutes in the home trades—together with the threat of war, provide a greater stimulant than any promptings of the May Committee.

[1] A few firms have made complaints. The complaints arising out of the spread-over scheme have some foundation (above, p. 502); others have been based upon the lower prices of 1939.

[2] C. H. Reilly, *Scaffolding in the Sky*, p. 339.

Appendix I

A NOTE ON THE PROCESSES IN 1867

Iron, the chief constituent of all kinds of steel, is not found pure in nature in commercially valuable quantities, but mixed or combined with oxygen, silicon, alumina, lime, phosphorus, sulphur and other materials. Hence though old iron and steel can be used in steel-making, the separation of iron from newly won iron-ore is a necessary initial process in any steel industry whose output is to be sustained, let alone expanded.

By 1867 this separation had for long been effected by smelting in a blast furnace. A mixture of iron-ore and coke (with limestone as a flux) was "charged" (which in practice meant "emptied out of wheelbarrows") into the top of a tall hollow firebrick "stack" encased in iron plates—in form a cross between a cone and a cylinder—at whose base, the "hearth" of the furnace, a fire had been kindled. The newest furnaces were eighty feet high. Combustion was maintained by blowing hot air through a number of pipes or "tuyeres" near the hearth, and in this region, where the heat was greatest, the ore melted, and the bulk of the non-ferrous "impurities" floated as a scum or "slag" on top of the iron. It was a simple matter to draw off or "tap" the slag and the iron separately; and when this was done more ore and coke descended to the melting zone, and more were charged at the top. The process was cyclical and continuous, a furnace remaining alight normally until the firebrick lining was burnt out. During the process a great volume of combustible gas was produced (its most important constituent being CO from the combustion of the coke), and this was utilised in the newer furnaces to raise steam and to heat the blast. The newer furnaces also had a new type of hot-blast stove. Hitherto the blast had passed through cast-iron pipes immersed in flames. The new stoves were composed of a network of firebricks encased in plates. This network alternately absorbed heat generated by the burning of the furnace gases, and transmitted the heat so absorbed to the blast. More than one stove was, of course, required for each stack.

Smelting did not produce iron entirely freed from the other materials in the original ore, and it tended to carburise the iron. As a result "pig-iron", as it was called, was not malleable nor capable of standing shocks or strains. Further refining was needed. In the early Machine Age this was effected by "puddling". The iron was brought to a pasty state in a reverberatory furnace, lined with iron oxide to absorb phosphorus. The success of the process depended on the manual skill of the puddler who with his rabble aided the separation of iron from cinder, working the iron up into spongy balls, about 1 cwt. in weight. These were squeezed ("shingled") under a steam hammer, whereby cinder loosely attached to the iron was detached and the iron consolidated. The iron was further consolidated by rolling (*q.v.* below), and cut into short bars. If fairly large pieces of metal were needed—e.g. for rails—a number of bars were brought to a welding heat, made into a "pile", and rolled together.

Until 1856 the only steels made were hard high carbon steels, made by processes which were costly and only well adapted to make very small quantities. Bessemer's invention of the converter in 1856 created the modern steel industry, introducing a new type of steel whose character and cost made it a competitor of puddled iron, which it soon began to supplant. In the new process pig-iron was refined by chemical means alone. Air was blown through several tons of molten pig-iron in a pear-shaped container, with the result that carbon, silicon, etc., were quickly and turbulently burned out. Carbon, which determined the hardness of the metal, was then re-introduced in desired quantities by additions of spiegeleisen (an alloy of iron and manganese with a high carbon content: it proved necessary to reintroduce carbon along with manganese). The steel, produced in a liquid form, was poured into a ladle, taken to the "casting pit" and there poured—"teemed"—into more or less rectangular moulds to cool into "ingots". Nothing now depended upon manual dexterity or strength; greater uniformity, certainty, and adaptability were brought within reach, a wider range of qualities could be made, and large masses—several tons in weight—could be produced in one piece, a source both of strength and of manufacturing economy.

In the 'sixties Siemens discovered the open-hearth method of making the same kind of steel as Bessemer. Cold pig-iron was melted

in a sort of firebrick bath by gas flames directed on to the top surface of the charge, and the oxidation of the impurities was achieved—not quickly as in the converter—with the aid of ores as reagents and scrap as a diluting agent. The furnace, despite its name, was wholly enclosed in firebrick save for the doors through which raw materials were charged, and a high flame-temperature was achieved by preheating the gas and air supplies, the heat of escaping gases—absorbed by firebrick "regenerators"—being used for this purpose.

Steel ingots, "stripped" of their moulds and solidified, were reheated to a white heat and "rolled", i.e. passed and repassed between one or more pairs of rolls or cylinders which, set one above the other and rotating in opposite directions, drew the hot metal through, and by compressing it elongated it and reduced and otherwise changed its cross-section. Rolling consolidated steel and made it into shapes useful for consumers. In 1867 *steel* rolling was only *rail* rolling, but the mills subsequently used for other steel products were similar in general terms to those used by malleable ironmakers, though handling larger masses. For sheets or plates plain cylinders were used, being brought closer together with each "pass". For non-rectangular sections (e.g. rails, or rods) and for rectangular shapes narrow in relation to their thickness (e.g. squares), grooved rolls were used. In this case the rolls were not moved closer between each pass but were "housed" almost in contact with one another. Each roll had a series of grooves cut in it, every groove in the upper roll facing one in the lower roll. The metal passed once through each of the openings thus created, which formed, as it were, a descending series. Broadly speaking all ingots were rolled in two mills, being "cogged" into blooms or slabs before passing to a finishing mill. For light steel products three rollings were commonly needed, blooms being rolled into billets or sheet bars before being rolled into rods, small sections, or sheets. It was at the outset always necessary to reheat the steel between each rolling. Rolled steel products requiring further rolling came to be known as semi-products.

Appendix II

PRIME COSTS AND OUTPUT

The statement commonly made that average prime costs in a steel-works tend to rise as output falls (or in other words that marginal are below average prime costs) is not true in all circumstances. This note attempts—rather tentatively—to show within what limits it is true.

There are, of course, two familiar factors which should tend to *raise* average prime costs as the output of a works *rises*. Not all workmen are of equal efficiency; and it sometimes happens that of the parallel units at one stage of production (e.g. the blast-furnaces) some are less efficient than others. Obviously if the plant has to be worked below capacity, other things being equal, the management will be disposed to lay off the least efficient workers and units. Differences of efficiency between parallel units—to take the second factor first—are only likely to occur in an old plant which has been expanded; they are more likely among furnaces than mills (since mills doing the same job side by side are rare); and they will certainly not always be the determining factor in selecting a furnace for stopping; more often perhaps the condition of the furnace linings is likely to be decisive. Hence the second factor can only be spasmodically effective, and not in all works. If anything the first factor seems even less significant. Its scope is narrowed by the extent to which wages are paid by results; 70 or 80 per cent of the workers have at least part of their wages on this basis. There is, too, a strong tendency to "ca-canny" in a works when work is short.[1] Moreover the effect of variations in workers' efficiencies must be spasmodic, for most of the work is done by large groups of complementary workers, and it is only when a whole group is taken on or off that changes of output can change the make-up of the labour force much. In the

[1] For example in 1938–9 the output per steel furnace in one works fell 15 per cent when the number of furnaces at work fell from 8 to 5, though the charging and tapping facilities were proportionately more ample and larger outputs were thus to be expected. Output per furnace recovered when the number at work increased.

continuous furnace processes this can only happen when the number of furnaces at work is changed; but as has just been seen factors other than labour efficiency appear to predominate in determining which furnaces shall be stopped.[1] In a mill, output can be reduced either by working fewer shifts per day or fewer days per week or fewer weeks per month. When the first choice is made, although small differences of efficiency may well distinguish the different shifts of workers, it is normal to lay off different shifts in successive weeks in rotation.[2] Trade unions urge this, and it also prevents the dispersion of the workers.

The tendency to rising average prime cost with *falling* output (assuming that wages and raw material prices and qualities are stable) derives from two sources—the character of the plant used in the industry, and the nature of the markets for steel. These sources may be examined in succession.

In any industry there are three possible ways of reducing the output of a plant below its maximum. First, where parallel units are used in a process the number of units working may be reduced. Second, the pace of a process may be lessened. Third, the length or frequency of the intervals between spells of working may be increased. With each of these certain drawbacks may be associated. The first is only commonly applicable where *many* units of relatively small capacity are used side by side; while stopping or starting a unit may be costly and stopping may occasion serious deterioration of part of the unit. The second may involve a loss of efficiency in the use of labour or materials. The third may raise appreciably the proportionate burden of the costs of stopping and starting.

In steelmaking the successive stages are not equally well adapted to the same method of reducing output, and the earlier stages are rather imperfectly adapted to any. In coke ovens the silica linings are ruined by cooling, hence continuity of work is essential; but though it is possible to reduce the pace to 30 per cent of normal, the labour force (paid mainly datal wages) remains almost unchanged,

[1] An open hearth furnace, for example, needs half-repairs every fourteen weeks or so, full repairs every thirty weeks; hence in a big melting shop there is always one furnace nearly ready for some repairs.

[2] In the case of a very prolonged reduction of output this would be changed, and the best available men used.

and variations occur in the yields of by-products which are on balance unfavourable.[1] Neglecting the by-products, the main change in prime cost if the output of a modern battery of ovens fell by one half, would be a rise in average labour cost from, say, 1*s*. 6*d*. per ton to about 2*s*. 9*d*.[2] Blast-furnace linings are not necessarily hurt by stopping, but they may be, and the process of stopping is prolonged and costly. Since the furnaces are of high capacity the first method of reducing output is in any case rarely available, and output must commonly be reduced by working slowly, less air being blown into the stack.[3] In a modern mechanically charged furnace the labour required is not reduced appreciably when this happens, and since wages usually only vary slightly with output if at all, labour cost moves inversely with output.[4] Other items of prime cost vary, but not uniformly, and in a general picture they may reasonably be neglected.[5] For a blast-furnace *plant* the picture of cost trends is much more complex than for a single furnace. For here, at certain stages, a unit may be taken off. At those points the units left in blast will be running at their best level, and average prime costs will thus be close to their minimum: not quite so low for there are some services supplied in common to all furnaces (gas cleaning is an instance) and the labour employed here is more or less unchangeable. Having regard to prime costs alone it is obviously desirable to work at one of these optimal points; but it is rarely possible,[6] and other factors may rule it out when at first sight it seems within reach; e.g.

[1] Some yields rise, others fall, and the net value per ton of coke falls.

[2] These figures were for 1936, for a plant making about 3000 tons a week—not the most efficient size, but quite common.

[3] Contrary to a commonly held opinion the output of a blast furnace can be varied within wide limits; a reduction to 60 per cent of normal is easily feasible and in depression possibly not uncommon.

[4] An up-to-date furnace making 400 tons a day would have an average labour cost of about 3*s*. a ton. But labour costs of 5*s*. a ton are not uncommon: and in old furnaces the cost exceeds 10*s*. a ton.

[5] If a furnace had its blast from a single engine—the best practice—blowing cost would rise as output fell, as the engine would be working below its designed load; but if the blast came from a common main the position *might* be reversed. Losses of heat through radiation are greater for smaller outputs; but sometimes, nevertheless, with lower pressures less coke is required, since maximum overall economy does not necessarily correspond with maximum fuel economy. Sometimes, too, lower pressure means there is less dust to clean out of the gas.

[6] It may sometimes pay to work at an optimal point and accumulate a stock of pig-iron.

it may be desirable to have several furnaces supplying iron to the mixer in a steelworks to ensure uniformity.[1]

Open-hearth furnaces are always stopped at week-ends, and if kept dry can safely be kept idle for long periods. The normal way of reducing output in a melting shop is therefore to take off a furnace, which involves no abnormal starting or stopping costs.[2] The pace of working can be changed, but every reduction of output automatically raises the piece rates on the furnace (owing to the character of the wage system) and gas consumption at outputs below normal tends to rise. A management would rarely try to reduce output this way,[3] and abnormally high or low outputs are both likely to betoken an effort to maximise the output of a shop in a boom.[4] Stable weekly furnace outputs mean stable fuel and direct labour costs. But if the output of a shop is reduced (by taking off a furnace) there are auxiliary services where the labour supply (e.g. at gas producers, charging machines and in the casting pit) cannot be reduced *pari-passu* with output; and to the extent that the workers here are paid datal wages a lower output involves a slight rise in average labour cost.[5]

In rolling mills it is usually more expedient to reduce the number of shifts than to work slowly, though in slack times the pace usually falls; the supply of steel is less regular.[6] The number of shifts may be

[1] While there can be no general rule, it seems a reasonable guess that in a modern plant, with coke ovens, prime costs would rise by 2*s*. a ton or more if output fell to 75 per cent, 3*s*. or more if it fell to 50 per cent. These are not regarded as optimal points, but the estimate is conservative.

[2] Starting-up costs are not very heavy; a few pence per ton only. But they would of course become heavier if less than a full week were worked.

[3] To do so is the less necessary since ingots can be stocked and used cold. The last cast of a week must always be used cold. Any increase in the proportion of ingots to be fully heated necessarily raises costs.

[4] Abnormally high, if the flow of gas is raised above normal; output is increased but gas consumption rises as the heat is less effectively transferred to the bath of metal. Abnormally low, if owing to the operation of an abnormal number of furnaces at the same time there are delays in the supply of charging and tapping facilities.

[5] There are presumably "optimal" points, where the number of charging machines or ladles and ladle cranes, etc., can be reduced.

[6] Deliberately slow working is not unknown. It increases the proportionate burden of datal wages and of fuel for re-heating; but there are occasional compensations; in one works, e.g., the cost of working the hydraulic tilting plant was said to be cheaper per ton at low pressures than at high.

lessened in two ways; you may either work for a spell of several shifts, and then close down for a spell: or you may reduce the number of shifts worked per day. The first method increases (1) the proportionate burden of starting-up costs (which is most generally important in re-heating furnaces, but is also important wherever steam power is still used[1]), (2) the tonnage of ingots and semis to be re-heated (in an integrated plant), and (3) the burden of routine inspection, greasing, cleaning away of scale, etc., wherever this is relegated to week-ends. The elimination of a shift per day may have little or no harmful effect if three shifts are replaced by two. In two-shift working it is normally possible to obtain at least 75 per cent of the maximum output of a mill, since roll changing, oiling and minor adjustments can be carried out in idle periods between shifts, instead of during shifts.[2] The burden of datal wages—which is not, of course, the major part of wage-cost—may be *less* in two-shift than in three-shift working. Against this there will be some increase in the average time for which ingots are heated before rolling, the heating furnaces will have to be kept hot while the mills are idle, and where steam power is used the boilers will in fact be kept active too in the idle spells. But the net advantage might rest with the two-shift system. There are said to be plants designed to work on this basis normally, the steel furnace and soaking pit capacity being adapted to it, being deliberately inadequate for supplying the mills at maximum capacity.[3] Any reduction from two-shift working to one-shift working is necessarily attended by increased average costs in re-heating and in raising steam, etc. Thus, broadly, if mill outputs fall below 75 or 80 per cent of maximum capacity average prime costs will rise, albeit perhaps slowly. Above that level it may be that the average will be *above* the minimum, though within the upper quarter the average will rise as output falls.

[1] The substitution of electrical for steam power leads to greater evenness of prime costs within works, lessening starting-up costs and making it unnecessary to have so large a reserve of power. The burden of unstable demands for fuel and power is passed on to the electricity supply companies.

[2] Perhaps some classes of work do not lend themselves to roll changing on this plan.

[3] I have been told this by consultants, but do not recall having seen such a works. One important re-rolling plant works on a two-shift system; nominally the shifts are 10-hour shifts, but the *working* time is 7 hours, each hour's work being followed by a half-an-hour's rest owing to the exhausting character of the work. In this works the output on *two* shifts actually exceeds the output on three.

Integration, it will have been seen, may increase prime cost variation at certain stages of production; but it is not the case that the elaborate means of fuel economy associated with and dependent upon it rapidly cease to be economies at all when output falls and become instead diseconomies. In a plant where fuel and power are all derived from the coal delivered to coke ovens, and where there are no alternative sources of supply, then a decline of steel output, which—*ceteris paribus*—would probably involve a fall in the *yield* of gas per ton of steel and certainly an increased consumption, must be met by an increase in the proportion of pig-iron to scrap charged in the steel furnaces. Actually works of this pure type are rare; but if a firm is forced to adopt a pig-iron/scrap ratio without reference to the price of scrap, and cannot substitute producer gas or solid fuel for coke-oven gas at some point, then a seriously unfavourable movement of comparative prime costs might conceivably occur. More usually a firm *has* a choice. Gas is sold, alternative mixtures of gas can be used, and electrical power is both bought and sold. Where this is so, though the prime costs in integrated production will rise *more* than in unintegrated production, they are unlikely to rise at any stage *above* the costs in unintegrated production, and at most they will remain below. How the net gains compare with the special capital costs involved in integration is not susceptible of a general solution; "each case must be judged on its merits", to use the jargon of select committees. With regard to the pig-iron/scrap ratio, it is to be noted that unintegrated firms will use more scrap sooner than integrated firms if pig-iron prices are kept up by combination; from a national standpoint it is probably preferable that scrap consumption should be *low* in a depression, so long as scrap is not heavily exported.

So much for the effects exerted by the nature of the plant used. The effects of markets are less complex. In this context steels of different composition and section are most conveniently regarded as different products. The fundamental fact is that products are ordered normally in quantities smaller than those which it is most economical to make. An open-hearth furnace is rarely designed to make less than 60 tons of steel at a heat;[1] a pair of rolls for heavy sections can

[1] Actually it is possible to vary slightly the constitution of each individual ladle of steel by throwing in small additions immediately after tapping and before teeming.

normally make upwards of a 1000 tons without being redressed. If less steel of a given composition is required than a furnace produces at a heat, then some ingots must be stocked until orders for a similar steel come in. (Hence there is additional capital cost[1] and additional re-heating.) If orders for a given section do not occupy a pair of rolls as long as the rolls can be worked unchanged, then the cost and delay of roll changing is a heavier burden than it need be for narrowly technical reasons.[2] It is manifestly desirable to bunch together orders for the same products, and this is attempted by advising potential clients in advance that certain sections are going to be rolled on a certain day. But complete success is not achieved; and inevitably if the rate at which orders come in slows down, the bunches of orders for similar products will tend to get smaller, unless buyers are to be subjected to exceptional delays. Hence, assuming the plant to make the same range of products, and individual orders remain of the same average size, then every decline in total output will tend to involve a rise of average prime cost for each product. It is likely that this rise will be accentuated in a depression by a fall in the average size of orders.[3]

It is idle to try to illuminate all this fully by statistics; too little information is available. Obviously if the average prime costs experienced in any plant were plotted on a graph they would not form a smooth and continuous curve. Presuming the parallel units in the plant concerned were equally efficient and reductions of output were expected to be relatively transitory, then minimum costs would occur close to the designed full output. As output fell the line would rise steadily until a unit of equipment could be taken off in one stage of production. The line would then drop abruptly, but not to the original minimum, and it would then rise from the new low point until another unit could be taken off, when there would be a further

[1] Additions to circulating capital (as by the carrying of more stock) are properly regarded as increasing prime cost; though I believe it is often the practice in the industry not to take this view.

[2] The roll-changing problem is far more important than the surplus-ingot problem. But it is not to be assumed that all rolls will make 1000 tons without redressing; some make as little as 50.

[3] Firms may also increase the range of products made in a mill by taking orders for products which the mill is ill-fitted to roll; and this will raise the average cost per ton of the whole output of the mill, but *not* the average for the original range of products.

abrupt drop to a low point not as low as the preceding one. And so on. The general (but not quite constant) trend of a curve through the low points would be upwards. Such data as are available suggest that average prime costs might be expected to rise by between 5 and 10 per cent if output fell from full to half capacity; but this is little more than a guess.[1] Were the parallel units not equally good in a plant, then most likely, but not invariably, minimum average prime

[1] The only comprehensive data that I know for any aspect of this problem are these German figures relating the volume of employment and output. The headings of columns are freely, but I hope not misleadingly, interpreted. (*Eisenerzengende Ind.* p. 79. There was a lock-out in Nov. 1928; hence no figures are given for this month.)

	Steel-melting capacity employed (June 1929: 100)	Number of workers employed (July 1929: 100)	Number of hours worked (July 1929: 100)
July 1928	88·4	101·2	99·8
Aug.	86·2	100·8	100·9
Sept.	83·2	100·1	97·5
Oct.	84·6	98·6	98·4
Dec.	79·4	96·0	88·8
Jan. 1929	98·8	97·7	99·8
Feb.	92·5	97·1	95·0
Mar.	91·9	97·2	95·5
Apr.	98·8	98·4	100·1
May	99·1	99·1	98·8
June	100·0	98·1	99·8
July	96·5	100·0	100·0
Aug.	90·7	99·3	98·7
Sept.	86·2	98·7	97·2
Oct.	89·3	96·6	96·8
Nov.	90·2	95·8	93·5
Dec.	84·2	94·8	91·9
Jan. 1930	85·7	94·5	93·3
Feb.	85·7	93·8	89·2
Mar.	80·7	93·2	86·4
Apr.	75·3	91·5	83·3
May	69·5	89·3	80·8
June	65·3	86·0	78·4

While there are striking but not surprising irregularities here, due largely no doubt to the rapid changes both in equipment and demand, the trend seems clear, and the ultimate rise of labour cost by 20 per cent per ton when output was down to 65 per cent is compatible with the argument of the text. If anything it favours the *lower* limit of probable cost variation. It should perhaps be made clear that the 5 to 10 per cent limits neglect the costs of changing from one level of output to another (e.g. the cost of blowing out a blast furnace) and assume that full adjustment to the new level of output (regarded as a short-period phenomenon) has taken place. The costs considered exclude all maintenance costs save those incurred in the short run by the act of producing (Mr Keynes' "User Cost"), and all costs of central administration.

costs would not be realised close to full output, but at some lower output. If reduction of output were so prolonged as to induce the elimination of the least effective workmen, then the disparity between average prime costs at high and low capacity working would be diminished; you would have a new, lower, curve for outputs of from, say, two-thirds of capacity downwards.

The initial assumption of stable raw material prices was obviously unreal; but to explore the extent and significance of their movements in different circumstances—particularly where these movements reflect chiefly bargaining strengths and bargaining skill—would lead too far afield. So too would the study of prime cost variation in the raw material industries; but it may be noted that available evidence does not suggest that average prime costs normally fall as output falls, but rather the reverse. It has been considerably more common in the last ten years for outputs per man-shift in ore mines to rise with a rising output and fall with a falling output than *vice versa*. The explanation of such figures is complex and must be reserved; but it is clearly wrong to assume the operation of a short-period trend to diminishing returns in ore mining.

Appendix III

PRODUCTION OF IRON ORE BY KIND AND DISTRICT, 1860–1937, TOGETHER WITH ESTIMATES OF ORE RESERVES[1]

	Annual output (000 tons)				Reserves (000,000 tons)	
	1860	1880	1913	1937	Actual	Probable
West Coast hematite:						
Cumberland	469	1491	1361	737 (51)*	40	72
Lancashire	521	1267	406	120 (54)	5	18
Jurassic ironstones:						
Cleveland	1471	6487	6017	2037 (29)	190	151
Lincolnshire	17	1155	2641	4386 (22)	335†	673†
Northants	96	1550	2916	3844 (32)‡	507	1155
Leicestershire	—	52	846	1069 } (25)§	102	158
Oxfordshire	6	8 }	153	851 }		
				733	78	40
Coal measure ironstones:						
N. Staffs.	738	1350 }	891	141 (33)	364	940
S. Staffs.	786	363 }		8 (30)	11	63
Scotland	2150	2659	652	23 (30)	8	77
Salop	166	277	2	—	—	—
Derbyshire	376	150	—	1	567‖	13‖
Yorkshire, West Riding	256	287	22	3	99¶	154¶
S. Wales	591	278	—	—	—	—
N. Wales	85	41	—	—	—	—
Warwickshire	20	18	—	—	—	—
Other occurrences:						
Cornwall	24	16	—	—	—	—
Devonshire	4	13	—	—	—	—
Somersetshire	24	29	1	—	—	—
Wilts	76	68	6	—	—	6
Gloucestershire	90	92	8	1	—	—
Northumberland and Durham	12	41	—	—	—	—
S. Wales and Monmouthshire	40	66	55	260	—	8
Total**	8024	18026	15997	14215		

* The figures in brackets show the average iron content in 1937.
† For N. Lincs. (Frodingham) the figures were 260, 238.
‡ For Inferior Oolites of Northants, Lincs. and Rutland.
§ For Middle Lias of S. Lincs., Leicestershire, Oxfordshire and Northants.
‖ For Derby and Notts. ¶ "Other Districts."
** Including a few items not listed.

[1] Output data for 1860 and 1880 from R. Meade, *op. cit.*, pp. 826–7, where they are reproduced from the official *Mineral Statistics*; for 1913 and 1937 from *Annual Reports of the Secretary for Mines*. Reserves from *Report of the Imperial Mineral Resources Bureau on Iron Ore* (1920).

Index

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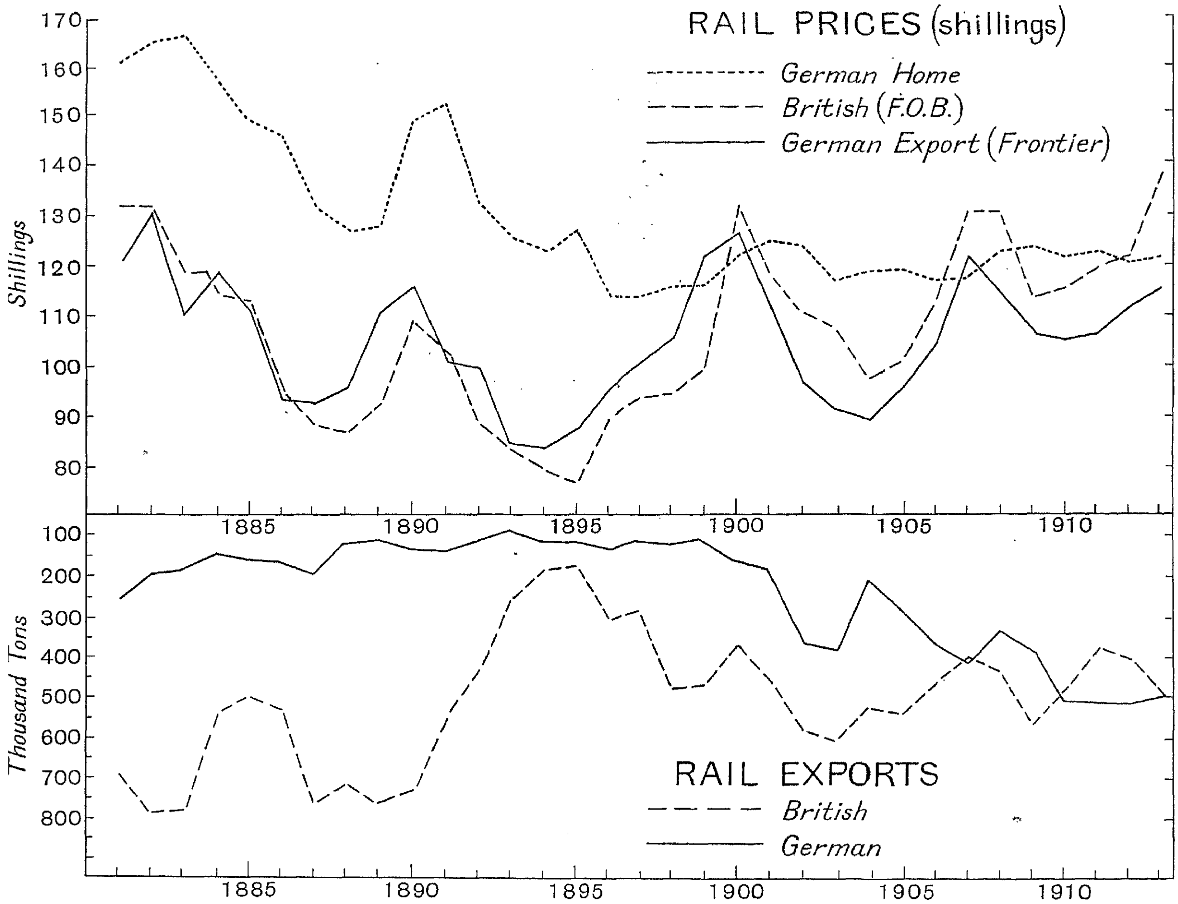
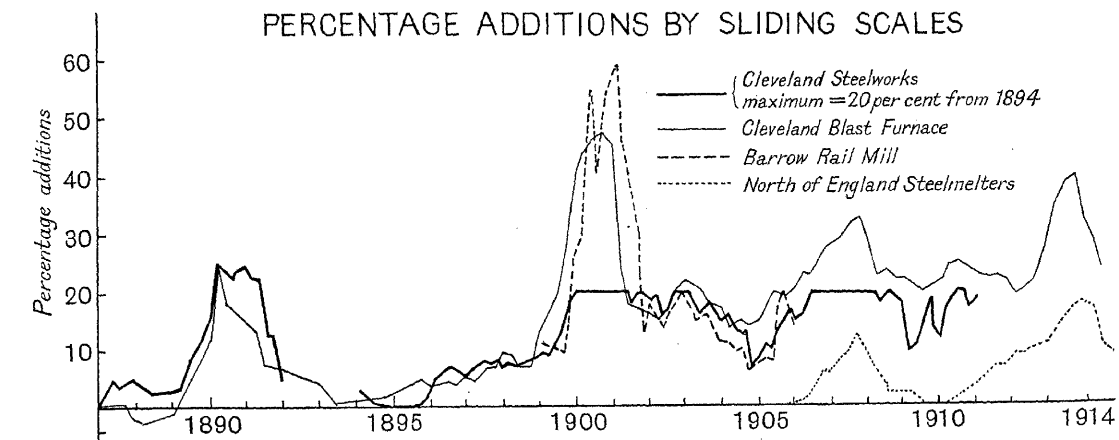
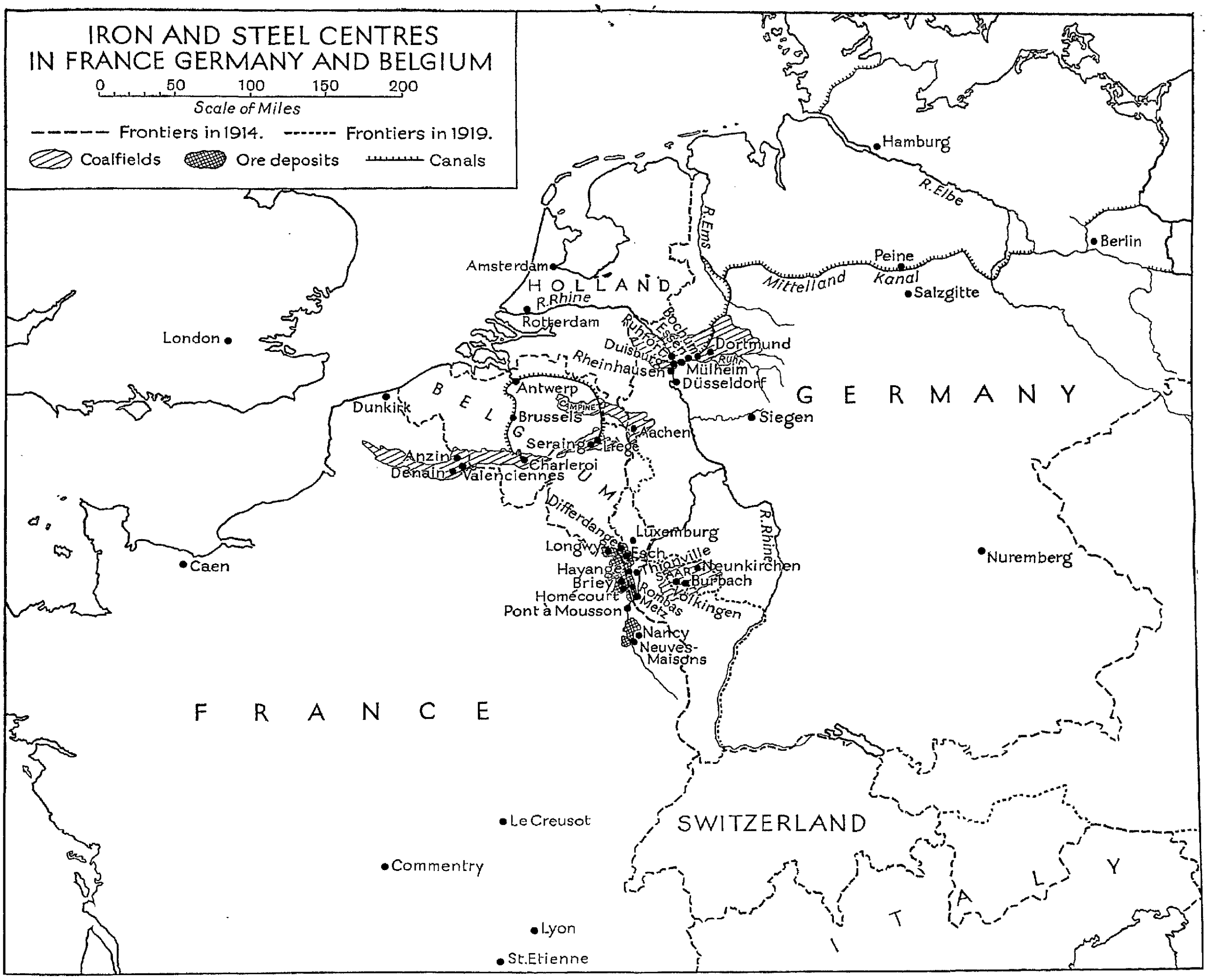
Fig. I


RAIL PRICES (shillings)
German Home
British (F.O.B.)
German Export (Frontier)
Shillings
170
160
150
140
130
120
110
100
90
80
1885
1890
1895
1900
1905
1910
Thousand Tons
100
200
300
400
500
600
700
800
RAIL EXPORTS
British
German
1885
1890
1895
1900
1905
1910


PERCENTAGE ADDITIONS BY SLIDING SCALES
Percentage additions
60
50
40
30
20
10
Cleveland Steelworks maximum = 20 per cent from 1894
Cleveland Blast Furnace
Barrow Rail Mill
North of England Steelmelters
1890
1895
1900
1905
1910
1914


WAGES IN GERMANY
Marks
1600
1500
1400
1300
1200
1100
1000
Wages at Essen (Marks per Shift, × 300)
Wages in Rhenish-Westphalia: Insurance Average-(Marks per Year)
1890
1895
1900
1905
1910
1915



IRON AND STEEL CENTRES IN FRANCE GERMANY AND BELGIUM
0 50 100 150 200
Scale of Miles
Frontiers in 1914.
Frontiers in 1919.
Coalfields
Ore deposits
Canals
Hamburg
R. Elbe
Berlin
Peine
Mittelland Kanal
Salzgitte
R. Ems
Amsterdam
HOLLAND
R. Rhine
Rotterdam
London
Dortmund
Duisburg
Rheinhausen
Mülheim
Düsseldorf
GERMANY
Antwerp
Dunkirk
BELGIUM
Brussels
Siegen
Aachen
Seraing
Liege
Anzin
Charleroi
Denain
Valenciennes
Differdange
Luxemburg
R. Rhine
Longwy
Esch
Thionville
Neunkirchen
Hayange
Briey
Burbach
Homécourt
Völkingen
Pont à Mousson
Metz
Nancy
Neuves-Maisons
Caen
Nuremberg
FRANCE
SWITZERLAND
Le Creusot
Commentry
ITALY
Lyon
St. Etienne